DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

JANUARY, 1982

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The Deep Submersible Pilots Association was formed in 1967 to provide for a free interchange of information relative to deep submersible design, operations, techniques, and materials on order to further the safe and peaceful progress of man into the deep oceans.

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EDITORIAL NOTES AND COMMENTS

As your Editor, I regret that I was unable to publish the DSPA NEWSLETTER for the Fourth Quarter, 1981. Maybe I'll do better in '82, but I do seem to be experiencing difficulty getting up to speed. I wonder if I have been holding down the job too long. Do I have a volunteer to relieve me?

It has occurred to me that the reporting of San Diego monthly lunch meetings requires condensation. After all, does anyone care to know which local members attended? Henceforth, only exceptions to the norm, members from out of town, and special guests will be considered newsworthy.

Enclosed with this NEWSLETTER is a revised address list, already, no doubt, requiring correction (sigh!) Please check your listing and advise me of discrepancies promptly--before you forget.

New members welcomed on board recently are as follows:

William Goldsby--International Underwater Contractors (PISCES VI), ex-SEA LINK.
Nihil Smith--Honeywell Marine Systems, ex-TRIESTE.
LCdr Lou Eyerly, USN--O-in-C, SEACLIFF; ex-TURTLE.

SECRETARY'S REPORTS AND NOTICES

Annual dues time is here again. Unless your membership card is marked for '82, you owe $10 U.S. for USA/Canada mailing addresses ... or $15 U.S. for overseas mailing addresses. Please indicate if you have a preference for mail to be dirested to your residence or business address. Send payment to your DSPA Secretary to avoid confusion. However, payment will be accepted by any DSPA officer if more convenient to you. Remember to allow for currency exchange rate variations and for bank draft charges.

Tim McClay and Jean-Marc Plancon have been dropped from DSPA rolls due to non-payment of 1981 dues. If any Member is in contact with either, please advise him that he may be reinstated by payment of dues for 1981 and 1982 plus a $10 fee.

DSPA-San Diego Luncheon Meetings have been held momthly excent for December since last reported in the August '81 NEWSLETTER with an average attendance of eleven. Items of interest discussed included:

SHINKAI-2000 experienced an extremely high initial failure rate with their cable connector potting. What else is new?!

Jack Bennett announced that AUGUSTE PICCARD safely completed the transit San Diego to Mobile under tow despite tug engine failure and several towline partings. At last report, she has since been engaged in treasure hunting expeditions off Venzuela. Jack has resigned as Project Manager.

PC-9 was acquired by Bob Eastaugh and resold to INFABCO.

The U. S. Navy now has a "Deep Submersible Pilot" qualification device.

Chris Landrum reported that his new partnership, HYDROSCAN, can provide a highly capable manipulator for "under $50,000".

Qualified diving bell and tethered manned vehicle operators may apply for "Associate Membership" in DSPA.

Ron Rau will be transferred to a new job with Lockheed in Texas. Jerry Shiller will relieve him of duties as DSPA Treasurer until the next elections.

The San Diego Section, Marine Technology Association, is taking an increased interest in submersible vehicles. Alternate monthly meeting guest speakers will discuss subjects in this field and a symposium is being planned.

Jack Bennett is making arrangements for RAdm Brad Mooney, Oceanographer of the Navy, to attend our February meeting.

LETTERS FROM MEMBERS

Alan Whitfield- HMB Subwork (8/12/81)

"Please find enclosed the latestI.U.P.A. Newsletter. I am still the diving superintendant on the Borgny Dolphin, currently operating a MANTIS in 1100 feet off Norway. In addition, the Sub School continues at Brighton Marina. We recently had a K-350 diving in the River Thames by Windsor Castle as part of a charity function.

JULY 1981.

1. Some general news about British Oceanics.Voyager did a short term flowline inspection during April.Now working the Brent area.Later this year may do dry transfer trials with the Royal Navy.(LR5 + LR3).
Comex Houlder + Oceanics have a 4 year seasonal contract (May 1981),for subsea inspection on the Tartan Field.British Enterprise 3 with LR2 + PC12.
British Enterprise 5. is now operating with Subsea Surveys using Consub.
British Enterprise 4. doing subsea inspection with PC1601 + PC1202.

2. I met Rodger Plant on a helicopter recently. Then with Trec 10 (Dolphin), doing inspection work at Statfjord. Also there were K. Brumby + B. Randle.

3. M. Howarth has been in Brunei, Borneo, with the rcv Ize (Subsea Surveys).

4. J. Stagg is with Subconsult running the rcv programme at Ekofisk. (Dart). Subconsult take delivery of a second Dart in the near future.

5. A new company has set up in Tananger called Wilco, operating a Mantis. This now gives three Norwegian mantis operating companies.

6. Pacnorse has been in the Gulf of Valencia, Spain, diving to 460ft with an Arms.

7. Discoverer Seven Seas working for Agip off Italy in 2700ft with Pisces VI.

8. The following companies are looking for rcv pilots and supervisors. Oceaneering, Subconsult, and Subsea Offshore.

ED.

OCEANEERING

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Oceaneering, the world's largest Underwater Contractors, providing services to offshore oil and gas industries worldwide, has immediate requirements for personnel with experience of remotely controlled vehicles as Supervisors, Pilots and Technicians. Based out of U.K., operations will be worldwide.

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Larry Megow-Hahn & Clay (9/3/81)
"Sorry to say, the memo I sent you on OTC contained a typographical error - the "Revenue into Houston economy" should have been $37,200,000 for 1980 and $50,000,000 for 1981. I thoroughly enjoyed the articles on Don Walsh; however, I was disappointed that the highlight of Don's life-his dive to the deepest spot in the ocean with Piccard in '46- was not even mentioned. I'll talk to Don about this next time I see him.

Ralph Hollis-ALVIN (9/19/81)
"We have ended up with a couple extra days here in Panama because the MELVILLE has problems and we need her as an escort. This gave me some

time to catch up on my reading. Just finished the DSPA Newsletter and thought I should drop you a note. Our schedule shows us arriving in San Diego the end of February for about three months of diving and maintenance. We would enjoy showing anyone who comes down to see us anything they wish to see. We are presently looking for an electrician for ALVIN who could also possibly train as a pilot. P.S. I am also a Ham Radio operator and would like to contact any of the DSPA members who also are Hams. There is a group of us who hang around 21,445 mc starting at 2200 GMT.

Frank Chambers-PISCES IV (9/21/81)
"We have been working off Halifax, Quebec, and Newfoundland since June and are now home on a few days leave. We go back next week to meet PANDORA/PISCES IV at Baffin Island and start working our way south. Will carry out ops off Bermuda in November and return to Victoria via the Panama Canal, home first week in December. It's been a long but very successful summer. By the way, the quote made about our 1,000th dive was excluding commercial submersibles. We felt that ALVIN was the only "Research" vessel ahead, which isn't bad when one remembers we're nine years old as opposed to 16. Anyway, all was with good intentions and in good fun , so I hope no one is overly disturbed.

Don Keach- Institute for Marine And Coastal Studies, USC (10/8/81)
"In reading the August NEWSLETTER, I note that you would like more information concerning SHINKAI 2000 and ARGUS. SHINKAI was launched in March 1981 in Kobe and, after completing sea trials this month, will be delivered by Mitsubishi Heavy Industries to the government (JAMSTEC). SHINKAI is a 3-man boat with a combination of US and Japanese hardware. Until Japan has her own backup emergency rescue system, CURV III may be asked to perform that function. Incidentallly, Japan is also building her own DSRV. Kawasaki, I believe, has the contract. ARGUS is a Soviet-built 600-meter boat operated by the Southern Department of the Institute of Oceanology at Ghelendzhik, on the Black Sea. The picture was taken in April 1981 at Ghelendzhik by Don Walsh. The Soviets operate 18 manned submersibles. Most of them are operated by the Fisheries Institute; but PISCES VII and XI, along with ARGUS, are operated by the Institute of Oceanology. The Gas Institute operates several more. Don and I hope to visit these other Institutes next summer on a more extensive visit to the Sovier Union. Before then, in May, we will be back in Japan and will get an update on the Japanese submersibles.

Larry Megow-Hahn & Clay (1/22/82)
"Attached is a late November 1981 news release on Japan's "2,000-m deep submersible research vehicle system" completed October , 1981. Should be of interest to all our readers."

2,000-m deep submersible research vehicle system completed

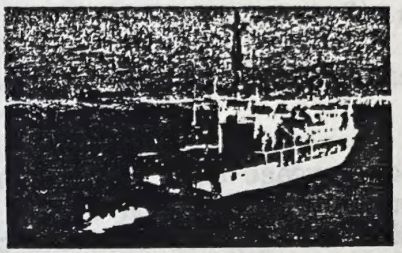
Japan's first exclusive support ship and submersible for a 2,000-m deep submergence research vehicle system were delivered to the Japan Marine Science and Technology Center (JAMSTEC) at KHI's Kobe Works this October 30. This completion of the total system will greatly assist in Japan's ocean development projects.

Kawasaki Heavy Industries, Ltd. constructed the support ship, "Natsushima," and Mitsubishi Heavy Industries, Ltd. built the submersible, "Shinkai 2000." KHI was overall coordinator of this system project, coordinating, for example, the system design, construction, sea trials, and so forth.

The keel of the "Natsushima" was laid at KHI's Kobe Works on November 16, 1979 and launching took place on August 21, 1980. After completion of outfitting work, sea trials of the "Natsushima" were commenced at the end of January, 1981. Then, total tests of the "Natsushima" and the "Shinkai 2000" were carried out from April to October, 1981 with the submersible descending to various depths down to 2,000 meters.

Prior to delivery, a 2,000-m submergence test of the system was conducted off Owase City, Mie Prefecture, on October 13. The test attracted a great deal of attention from the press and the "Shinkai 2000," with three crewmen aboard, succeeded in descending to a depth of 2,008 meters. The positions of the "Natsushima" and the "Shinkai 2000" and the position of the "Shinkai 2000" relative to the "Natsushima" could be detected precisely by means of the "Natsushima's" transponder accoustic navigation system. Communication between the "Natsushima" and the submersible were also very clear despite the great depth. Other tests were quite successful in confirming the functions and performances of various related system equipment.

As planned by the Science and Technology Agency and JAMSTEC, the "Natsushima" will serve as the support ship for the 2,000-m Deep Submergence Research Vehicle. It will carry the "Shinkai 2000" to various sites where survey and research are to be carried out and place it on the sea by means of a specially designed A-frame crane. While the "Shinkai 2000" is submerging, the "Natsushima" will provide various supporting activities. As a sea base, the support vessel is fitted with highly-sophisticated research and support equipment, including launch/retrieval, maintenance and servicing equipment, to assist and maintain the "Shinkai 2000" during its operation.



The support ship "Natsushima" and the submersible "Shinkai 2000."

The "Natsushima" has the following features.

1. An A-frame crane is installed astern aboard the ship for launching and retrieving the submersible (approx. 23 tons in weight). The crane is controlled remotely from the aft wheelhouse located on the top of a hanger.

2. The hanger is situated on the upper deck for ease of maintenance and servicing of the submersible. A trolley facilitates carriage of the submersible between the hanger and the launching/retrieving area.

3. To ensure highly efficient underwater activities at a high level of safety and to support the research activities of the submersible, there is an underwater navigation supporting system consisting of the most modern technologies that comprehensively covers the oceanic ship's position location, anti-collision factors, tracking of the submersible, radio communication, underwater telephony, environment research in the waters and investigation of marine topography. Centralized monitoring of this system is accomplished in the directing room next to the wheelhouse.

4. In an effort to achieve the best possible performance of the acoustic equipment, which is a vital component of the ship for support of the submersible, control of the underwater radiation of noise has been ingeniously embodied to a degree not paralleled by any ordinary ship.

5. The "Natsushima's" facilities include a shipboard laboratory where samples taken by the submersible can be properly processed and film developing equipment for interpretation of photos showing the condition of the sea bottom.

6. Also provided aboard is complete equipment making the vessel a sea base for the submersible. This equipment is sufficient to handle the maintenance and servicing needs for about ten submergences in a single sortie.

7. To improve maneuverability of the ship at a speed low enough to meet the mission of support, there are provided two sets of the C.P.P. driven by diesel engines, (two sets), two rudders and a set of motor-driven bow thrusters. It should, however, be noted that, unlike an ordinary ships, the C.P.P. can be controlled with respect to revolutions per minute in three different modes as may be required for particular motions of the ship.

8. The accommodation quarters and navigation outfittings have been designed to meet all the needs for activities of the ship in any corner of the world's oceans as well as in the waters adjacent to Japan. ●

Principal particulars of the "Natsushima"

Length o.a.	: 67.355 m
Length p.p.	: 60.0 m
Breadth mld.	: 13.0 m
Depth mld.	: 6.3 m
Draught	: 3.75 m
Gross tonnage	: 1,553 t
Cruising speed	: approx. 12 knots
Cruising range	: approx. 10,800 nautical miles
Class	: NK
Accommodation	: 30 persons (ship's crew) 25 persons (operational personnel)
Main Engine	: 2 sets, diesel engine MCO 850 PS x 950 rpm/set NOR 720 PS x 900 rpm/set
Propeller:	2 sets, controllable pitch propeller (220/107/84 rpm)
Generator	:
Main	2 sets, diesel engine driven 500 KVA x 440 V/set
Auxiliary	1 set, diesel engine driven 250 KVA x 440 V
Bow thruster	: Motor driven, controllable pitch propeller type 220/110 KW x 920/360 rpm

Alan Whitfield- HMB Subwork (1/25/81)

OCTOBER 1981

'SCANNINGS'

1. The recent James Bond film 'For your eyes only', featured interesting dive scenes with Mantis (piloted by G. Hawkes), JIM, and a Perry sub.

2. Oceaneering has moved to new offices near Aberdeen Airport. This will now be the worldwide centre for one atmosphere diving systems. D.H.B. have also moved their operations from Alton to Aberdeen.

3. Solus Ocean Systems I understand, now have a Perry one atmosphere bell working off Australia. (Rodgers & Laferty) on a long term contract.

4. Nordex Wilco used their Mantis to survey the Statfjord Platform in Stavanger Fjiord.

5. RCV news. Comex is to increase their operations with 5 Scorpio units and one 225 unit. Consub 2 and BE5 have been working on pipeline inspection (Frigg).NUI in Bergen has been the centre for trials with MMIM the new BP vehicle (G. Last). Scotsub have been operating a dart on the Montrose Jacket, doing inspection. (P. Sheader & K. Brumby) Fuga is still on trials and evaulation at N.U.I. Bergen.

6. Submersible support vessels at September 1981 were doing the following

   a) British Voyager - flags, AUK
   b) B.E.I. - Mediterranean for 60 days as support vessel for a geological survey
   c) B.E.2 - on charter to CUE for air diving
   d) BE4 - Tartan field, pipeline inspection
   e) Ragno Due - Magnus field, flowline work, diver support with the Castoro sec

7. B Pick, P. Evans and D. Smith have left Oceanics and joined HMB Subwork, P. Bunce has left Scandive and joined Oceaneering.

SCANNINGS.

JANUARY 1982.

1. British Oceanics has laid off 44 people.This will result in only one ship,and two submersibles being operated during 1982.

2. Intersub Services has ordered a 400m submersible from Comex Industries. To be delivered in May 1982.Also on order,two Scorpi and one snurre remote vehicles.

3. Pilots still with BOL,appear to be : Wrightson,Jury,N.Jones,Bloor, Hebourn,Herron,and Mills.

4. B.Randle has been in Palawan,Philippines,with Trec.IO.(SSO). T.Maudsley has been with Scotsub,recovering a plough in the Atlantic. Now with Comex,on the Uncle John. P.Sharphouse is with Scorpio.5. (SSO),on the Ocean Endeavour in Tunisia.

Ross Saxon

NAUTILUS ENVIRONMENTALS, INC.

October 16, 1981

Mr. Robert K. R. Worthington
Editor and Secretary, DSPA
3005 Curie Street
San Diego, California 92122

Dear Bob:

I really am still alive and well and must apologize for not having written to you sooner than this. I fully recognize that the DSPA newsletter requires in put from the members in order to make it a meaningful document and in this I admit to having been quite remiss.

As you know, somewhat over two and one half years ago I was asked to take over as the President of Nautilus, a small firm specializing in the delivery of diving equipment which at that time was near bankruptcy. In the intervening period of time we have grown from a three person organization to now employing 25 persons and from an annual gross revenue position of about $400,000 to well in excess of 10 million dollars this year. We are actually specializing in the delivery of life support equipment serving four primary areas of activity: 1) diving systems and support equipment; 2) hyperbaric medical systems; 3) altitude training systems; and 4) clean air breathing systems for industrial activity.

In addition to the above, we are very heavily involved in working in developing nations to assess their overall requirements relating to diving and marine activities; to develop a plan of action to meet specific goals formulated between them and ourselves; and to provide the equipment and training necessary to reach those goals. Such activity takes us into a full spectrum of services wherein we become involved in harbor construction, in light salvage activities, in ship husbandry and other areas relating to marine activity.

Our largest single project to date is a contract for the delivery of an aeromedical laboratory which will be utilized by the Nigerian Air Force in Kaduna, Nigeria. This facility will incorporate a very large hyperbaric medical chamber system, a large altitude chamber system for hypobaric activity, a centrifuge, a vertifuge, the necessary installation assembly test, training and long term maintenance. We are presently preparing a graphic illustration of the facility and as soon as that is complete I will send you a copy.

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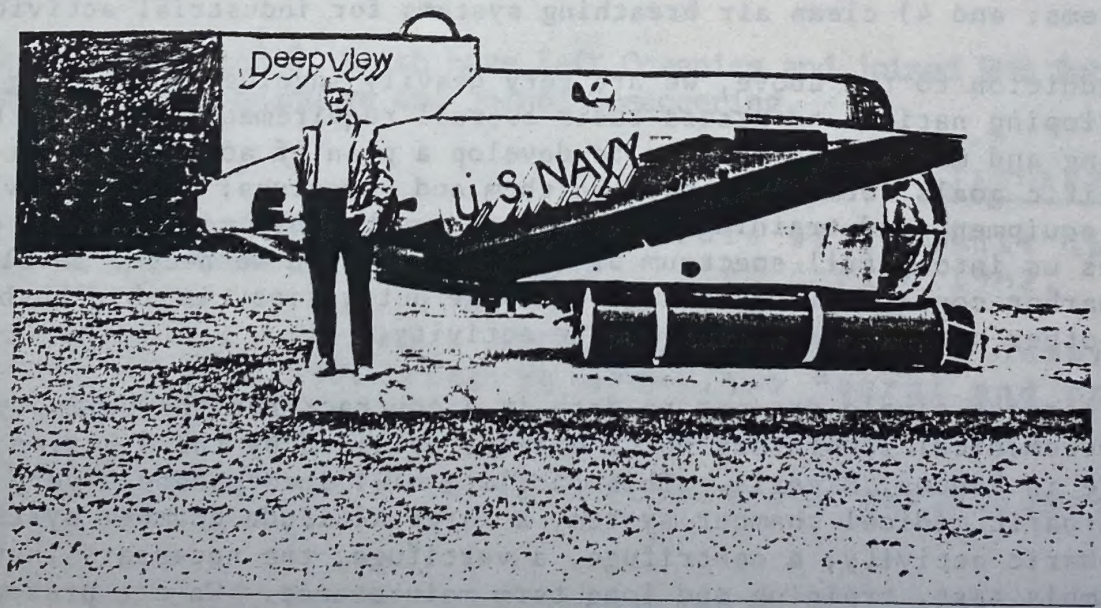
Some of the folks we have with us are Bob Bryant who was formerly the President of J and J Machine and Diving and prior to that a Vice President of Perry Oceanographics; Bob James who heads up our Norfolk office has retired from the Navy with some 31 years of service; Pat O'Connor formerly with Perry and Ocean Systems who I believe to be one of the foremost diving equipment engineers in the world; and George Koesters who is our Vice President of Production and Materials, also an individual with many years of experience in the diving industry.

I regret the fact that we don't have any offices in San Diego or at least anywhere in California where I can periodically attend the DSPA meetings. Hopefully, there will come a point in time when there is sufficient amount of activity on the West coast to be able to let me get back there more frequently, but this is most likely several years in the future.

Bob, that's about it for now, but I did feel that I had an obligation to go ahead and drop you a short line, at least to tell you that I was alive and well and still interested in DSPA. Please give my regards to the other members in San Diego who may still remember my name.

Larry Megow- Hahn & Clay (2/2/81)
"Back in 1972, Will Forman's 1500',49" diameter DEEP VIEW was christened in San Diego. You will be interested to know that on January 27, 1982, I found DEEP VIEW on display at the NOAA NASA/ NSTL Naval Ocean Research and Development Activity Station, near Bay Saint Louis, Mississippi. I also found Bill Rainnie, former Chief Pilot of ALVIN. Bill is now employed at NSTL/ NOAA working on various oceanographic research and development projects, including buoys for advancing current ocean environmental technology."



Soapbox

The Ocean Floor— A Renewed Frontier

Dr. Alexander Malahoff is currently Chief Scientist (Geophysicist) of the National Ocean Survey, National Oceanic and Atmospheric Administration (NOAA), a position he has held since 1976. Before NOS he was Program Director of the Marine Geology and Geophysics Program at the Office of Naval Research.

Geophysics has been providing for the geologist the necessary third dimension for the interpretation of structure and the mapping of geological resources. Marine seismic reflection and refraction, pioneered in the 1950s at the Woods Hole Oceanographic Institution, the Lamont-Doherty Geological Observatory and the Scripps Institution of Oceanography, opened a new door into understanding the structure of a previously unknown section of the Earth's crust: the ocean floor.

The names of seagoing pioneers stand as landmarks in advancing the techniques of marine geophysics and the insight into the structure of the oceanic lithosphere. In the advance of the 1950s and 1960s they were followed by the explosion of Vine and Matthew's hypothesis of sea floor spreading and the plate tectonic theory of Molnar, Oliver, Sykes and others of the 1960s.

Through the eyes of these pioneers wielding the tools of marine geophysics—gravity, magnetics, heat flow and seismology—we have been able not only to construct the structure of the modern oceanic lithosphere but also to develop the relationship between the depth of the ocean and the age of the oceanic crust.

Geologists have traversed the surface of the continent for almost two hundred years, linking their observations of surface geomorphology to extrapolation of geological studies.

The surface of the ocean floor is, by contrast, another dimension. It has not been traversed visually, except along a few selected locations, so that perhaps 99.99% of the area, or in other words almost two-thirds of the world's surface, has not been trod upon nor seen by mankind.

The reason for this is obvious. First of all, it is difficult to get to the ocean floor either by camera or submersibles, and secondly, the remote shipboard geophysical techniques lack the resolution to adequately define the ocean floor for geological purposes.

With a stroke of perceptive genius, Bruce Heezen and Marie Tharp defined for us, in the 1960s and 1970s a perspective global view of the ocean floor through their physiographic maps, demonstrating the global continuity of the mid-ocean ridges, the continuity of the fracture zones and the presence of the seamounts on much of the ocean floor of the western Pacific.

However, it was the electronic strobe light and pressure-encased cameras of Ewing, Edgerton, and others that permitted the first view of the ocean floor. The greatest advances were made by the deep diving submersible *Alvin*. Its operations led to the exciting and unpredicted discoveries of the late 1970s.

Let us briefly review these discoveries. The combination of three areas of high technology allowed mankind's first detailed view of the processes of sea floor spreading along the axis of the mid-Atlantic Ridge. Led by Heirtzler and Ballard of the United States and the French team of LePichon of France, the submersibles, *Alvin, Cyana,* and the Bathyscaph *Archimede* descended into the depths of the rift valley.

A highly fractured ocean floor and a rift valley dotted by active submarine volcanic cones, were there to greet the observers. The observers had already obtained a detailed bathymetric view of the dive sites prior to the development of the submersible. The success of this FAMOUS expedition was made possible by the pre-dive surveys using the SASS multibeam U.S. Navy surveying system.

The high-resolution imaging of the ocean floor was made possible through the use of very narrow acoustic beams used in a swept mode from a surface vessel to produce real-time contoured maps of the ocean floor with a resolution that is several magnitudes superior to the normal wide-angle shipboard echo sounding systems currently in use.

By the late 1970s mineral formations had been discovered. An analysis of the geochemistry of the polymetallic sulfides led to a search for continental deposits of oceanic sulfides. Every new dive along the East Pacific Rise is leading to new discoveries of active, and inactive polymetallic sulfide mounds and exotic animal communities.

In the meantime, a civilian multibeam ocean floor system, the SEABEAM, had been developed and installed aboard the French Vessel *Jean Charcot* and the U.S. Vessel *Surveyor*. In a classical combination of a multibeam site survey over the crest of the Galapagos Ridge, followed by carefully controlled acoustically navigated bottom photography with the *Angus* system and visual dive site selection from the bottom photographs, Ballard, Francheteau, and Grassle came upon the exciting giant worm and clam communities of the hydro-thermally active crest of the Galapagos Ridge.

A few months later, *Alvin* and *Cyana* explored the active polymetallic "smokers" of the East Pacific Rise. New technology deep-towed high resolution side scan sonars such as the *Gloria* system of Britain or the *Sea Marc* system of the United States show promise for rapid mapping.

New low-light, towed television cameras open up vistas for the direct viewing of the ocean floor.

What shall we find along the remainder of the 99.99% of the 44,000 miles of the world's ocean ridge system and other tectonically active areas of the ocean floor? The answer is limited only by the extent of vision and curiosity of the explorer of the ocean floor. □

U.N. Sea Law Parley Ends; Completion Of Plan Is Sought In '82

New York Times News Service

GENEVA — A United Nations conference that has been at work for nearly eight years ended its 1981 session yesterday by vowing to complete in New York next spring its ambitious attempt to draft a global charter governing man's use of the seas and their resources.

However, the adjournment came with the 146 participating nations still not assured that the United States will return to the negotiating table after having abstained from joining in substantive negotiations here or at earlier talks in New York this year.

James L. Malone, the U.S. special representative to the Law of the Sea Conference, said here that he expected the Reagan administration to complete by late fall the review it undertook on taking office of the draft treaty that preceding administrations had helped compile.

While Malone stressed at a news briefing that Washington had undertaken no commitment to return to the negotiations, he also expressed the hope that a "positive decision" would be taken once the review was completed.

Malone may have tipped Washington's intentions when he told the conference yesterday that four weeks, instead of the three projected, should be reserved at the outset of the eight-week New York session for the informal consultations needed to make quick progress on the many changes the United States is expected to seek in the proposed treaty.

Washington's decision on its future stance will be influenced greatly by its assessment of the receptiveness given to its concerns on the present draft treaty's provisions on the mining of the deep seabed for mineral-rich nodules by the more than 120 developing countries.

The third world fears that the United States and other industrialized advanced countries will sweep clean the seabeds under international wasters of the nodules bearing copper, manganese, cobalt and nickel unless their interests are adequately protected in the treaty.

But the Reagan administration believes that the concessions made by its predecessors will place undue restrictions on seabed mining by private enterprise to the detriment of its national interests.

Despite the tough official stance of the developing countries against altering any of the "fundamentals" of the present draft, Malone said after private talks with them here that they showed "some flexibility and latitude."

This attitude was shown toward possible admendments to treaty that would be "not only changes that are superficial or cosmetic in nature, but indeed important changes," the U.S. official said at a news briefing.

While the developing countries are clearly anxious to have the United States participate in the proposed treaty, they insist that the treaty must be concluded, with or without Washington, at the session to open in New York on March 8.

For Tommy T. B. Koh of Singapore, the conference president, the conference gave the United States a "clear signal" that it intended to complete the treaty at the New York meeting by terming this round the "final decision-making session for the adoption" of the pact.

A refusal by the United States to join in the treaty would be a cause of serious concern for Washington's Western allies, who do not want to see the most ambitious treaty-making effort undertaken by the United Nations founder on the seabed mining issue.

With the United States mostly keeping to the sidelines, the conference was able to accomplish little this year.

At the final four-week Geneva session, it did decide that the proposed agency, the international seabed authority, for overseeing seabed mining would have its headquarters in Jamaica, while the projected international law of the sea tribunal would be established in Hamburg, West Germany.

Of the major outstanding issues left at the end of last year's session, only the question of the delimitation of overlapping boundaries between facing or adjacent states was tentatively settled.

This was accomplished by abandoning the attempt to decide between rival theories on how such boundaries should be drawn in favor of leaving it to the states concerned to reach an equitable agreement by direct negotiation.

Mining Industry Still Opposed to Draft Law of the Sea Treaty, But Hopeful of Treaty Review Outcome

U.S. mining companies interested in deep seabed mining are still maintaining that they will not be able to risk further investments necessary to proceed with seabed mining development without an improved Law of the Sea (LOS) treaty. While passage of the Deep Seabed Hard Minerals Resource Act provided some protections and incentives to proceed with initial development of technology, the industry says it will not proceed further.

Ambassador Elliot Richardson, former head of the U.S. Delegation to the U.N. Conference, told a House Committee last month that after consulting with all the mining consortia, he found none willing to make further investments without an amended treaty. He also reiterated the view that while the mining industry has been in favor of the Reagan Administration's treaty review, it is still very interested in having the U.S. negotiate a workable international treaty, and in fact would not be able to mine the seabed without one.

The 10th session of the U.N. Conference on the Law of the Sea will continue in Geneva from August 3 to August 28. As of press time, the treaty review was not expected to be complete before this session. If this proves the case, the U.S. Delegation would not be able to actively participate in the negotiations.

Answering concerns about the possibility of the conference adopting the existing draft treaty without the U.S., James L. Malone, current head of the U.S. Delegation, has said that most countries at the conference know that it is in their own best interests to have the U.S. included in the treaty.

))) **"Hot Spot" Deep Sea Polymetallic Sulfides Excite Interest.** From these deep sea hot spot areas of the Pacific Ocean there was news last month of rich ore deposits. If assays of samples taken so far show the promise hinted by marine geologists current deep sea mining negotiations of the United Nations Conference on Law of the Sea (UNCLOS) could be affected strongly, some observers believe. Late in September samples were brought back from the Galapagos Ridge west of Ecuador, taken at depths of 3,000 meters. They were being assayed by the Department of the Interior's Bureau of Mines. They were obtained by Dr. Alexander Malahoff, chief scientist (geologist) of the National Ocean Survey of the Department of the Interior, diving on the site of seafloor spreading in the submersible *Alvin*, whose manipulator arm dug the samples.....Scientists hoped that the assays will show rich concentrations of valuable metals, especially silver.....Piled on top of this was the news, revealed at the Oceans '81 Conference and Exhibition in Boston Sept. 16-18, that Dr. Robert Ballard of the Woods Hole Oceanographic Institution had discovered more rich deposits in the area of the Easter Island Fracture Zone of the east Pacific Rise. Ballard, who pioneered in exploring the ridge seafloor spreading zones of the Atlantic and Pacific, says that at the fractures near his most recent finds the spreading rate is 18 centimeters a year, permitting ejection of an increased amount of the rich ores from the earth's mantle. The Galapagos spreading rate is 6 centimeters and the Mid-Atlantic Ridge 2 centimeters. Ballard believes that mining of the rich ores will become widespread in the near future and foresees development of a new mining industry, with greater returns than from manganese nodules at depths of 5,000 meters. Mining would take place at sites of former hot spots rather than the present spots where magma oozes from the earth's interior.....The third area that has excited scientists is the Juan de Fuca Fracture Zone off Oregon and Washington. H. Edward Clifton, chief of the Pacific-Arctic Branch of Marine Geology of the U.S. Geological Survey last month revealed the discovery of polymetallic sulfides 270 miles off the coast of Oregon. He said that anlayses of water, ore samples and photographs were expected to show copper and zinc sulfides and possibly silver.....That discovery was in international waters. According to present sea law based on the treaty of 1958 any bottom resources beyond the 200 meter depth line belong to the adjacent nation if a resource is exploited.

Interest Continues in Deep Sea Polymetallic Sulfides

A recently discovered polymetallic sulfide deposit in the Pacific Ocean along the Galapagos rift valley about 350 miles west of Ecuador contains an estimated 25 million tons of minerals of which 10% is shown to be copper.

This assay, made by the Bureau of Mines of the Department of the Interior for the National Ocean Survey, was not available when the discovery of the rich ores was first announced by Dr. Alexander Malahoff, chief scientist of NOAA's National Ocean Survey. (For details see *ST* for October, page 9.)

Other minerals found in the deposit include 0.03% silver, 0.01% cadmium, 10% iron, 0.1% molybdenum, 0.1% lead, 0.03% tin, 0.1% vanadium and 0.1% zinc. Copper content worth alone is estimated to be $2 billion.

The Galapagos deposit is estimated to be 40 m thick, 200 m wide and about 1 km long. It lies along the rift valley at depth of 2.48 km, or 1.54 statute miles.

The submersible *Alvin*, owned by the Navy and whose operations are funded by the Navy, NOAA and National Science Foudation, was used in retrieving samples. One large chunk weighed over 90 kg.

Malahoff stressed that the polymetallic sulfide deposits are entirely different from manganese nodules. The nodules, also polymetallic, take millions of years to form in the deep ocean basins. The sulfide deposits are deposited along rift valleys and fracture zones in 100 to 200 years.

Scientific Freedom and the Sea

As one of the small band of professional marine scientists who have actually been delegates to the UN Law of the Sea Conference and who have been actively involved in negotiating some of the texts, I was most interested to read David Ross' article on marine scientific research. (*Eos, 62,* Sept. 1, p. 652). I was particularly glad to see that he urged a constructive attitude toward what many scientists seem to feel is a totally unjustified attempt to curb their 'freedom.'

Two aspects of the negotiations were particularly important in this regard. First, it was found impossible to differentiate satisfactorily between academic, economic, or military research. Much marine research (for instance that concerning gravity or water column temperature) is equally valuable to all three. Much apparently 'scientific' research is carried out by academic personnel using commercial subcontractors and supported by military funds. Typical of the confusion were large gravity, magnetic, and bathymetric surveys carried out by the U.S. Navy and NATO over the continental shelves of many Atlantic and Mediterranean coastal states (without notification or consent) during the 1960's, presumably under the justification that they were primarily military in purpose and therefore not covered under the existing 1958 agreement.

The resentment and mistrust that was created among the smaller coastal states by this and similar kinds of action was the dominant atmosphere under which the early framework of the marine scientific regulations was laid down. Representing one of the smaller coastal states myself, I became aware of many other examples of abuse that had occurred in the name of scientific freedom by universities and agencies who believed that they were working for the greater good. The harvest of regulations which we now face is undoubtedly one which we ourselves planted. In my opinion, too many scientists forgot that what feels like freedom from the deck of a ship looks much more like arrogance when viewed from the shore.

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Pacific Geoscience Centre
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Battelle Press Publishes Book on Underwater Tools

A manual on underwater diver and manipulator tools, "Underwater Tools", has recently been published by Battelle Press. The manual, co-authored by Donald J. Hackman and Don W. Caudy, is intended for use by managers, engineers, scientists, divers and technicians involved in the fabrication and use of such equipment.

The book includes chapters on: diver and manipulator characteristics, the characteristics and applications of underwater tools, underwater power sources, underwater design considerations, component selection and underwater work systems of the future.

The 160-page manual is $32.95 and is available from Battelle Press, 505 King Avenue, Columbus, Ohio 43201 telephone: 614/424-6393.

Graduate Enrollment in Oceanography

Charles D. Hollister and John G. Sclater

Excellent job opportunities exist for well-trained Ph.D. graduates in marine geology, geophysics, chemistry, dynamical-physical oceanography, and oceanographic engineering.

This was one conclusion the deans of various schools of oceanography reached at a conference that included deans from Dalhousie University, Florida State University, the University of Hawaii, the University of Miami, Oregon State University, the University of Rhode Island, Scripps Institution of Oceanography, Texas A & M University, the University of Washington, and the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Oceanography. The results of this effort, combined with some of our own notions, form the basis of this short report. We hope that these thoughts will serve as a discussion base for more in-depth reflections.

The information supplied by each institution revealed that in the years just prior to the meeting in 1980 there had been too few qualified applicants in the fields of physical oceanography, geologic-geophysical oceanography, and ocean engineering to fill available vacancies. Each institution reported that over 50% of its total applicants were in biological oceanography. The supply of chemical oceanography applicants appeared matched to demand. Mathematics was generally found to be the principal weakness in many of the applications regardless of discipline.

On the demand side, there were found to be too few Ph.D.'s for the job market in all fields of oceanography except biological oceanography, although most well-trained (cross discipline) biologists had little trouble in this regard. Other statistics that emerged included (1) acceptance rate for offers of admissions averaged 50%, (2) average time to Ph.D. from B.S. degrees was about 6 years, and (3) drop out rates generally averaged about 25%.

Graduates who have the strongest background in the basic sciences were considered more attractive by recruiters, and those students who investigate a problem as it traverses disciplines seem to do better in the job market than those that confine their interests to the bounds a single discipline.

The time, effort, and expense of recruiting certainly seem worthwhile, for institutions that did creative recruiting acquired a higher percentage of the candidates they had sought. Recent preapplication recruiting has substantially increased the number of good applicants to a given school. Success was also reported when active research scientists recruited in schools not already affiliated with oceanographic programs and in departments such as physics, math, chemistry, and engineering.

One recent proposal to AGU to do broad-scale, nationwide recruiting and lecturing about career opportunities in oceanography, in a nonschool specific fashion, has been declined. Thus it appears that each school will have to mount its own effort. Paid advertisements in school newspapers and journals widely read by undergraduates may be one way of initiating such an effort.

The prevailing Washington, D.C., mood, as reflected in the recent skirmish over NSF Graduate Fellowships, suggests that support for these fellowships will probably come under renewed attack next spring. It was concluded that graduate student support will be increasingly hard to find anywhere.

If present economic trends in this administration continue, we will have to rely even more heavily on the supply side of the economy to support the training process of our new scientists. Cross-sectoral linkages between industry and academia must be forged as soon as possible if industry expects to continue to reap the harvest of well-trained oceanographers that it has enjoyed up to now.

U.K., France Now Lead In Submersible Building

Staff Report

Offshore oil and gas exploration, drilling and production continued to dominate the market for submersible services in 1980. The most dramatic change was the upsurge in the use of unmanned submersibles, called Remotely Operated Vehicles (ROVs).

Diving companies are buying ROVs to make their suite of equipment more appealing to customers and complement their stables of divers. Carl Helwig of Subsea International, New Orleans, told *ST* that of his company's total increase in personnel in the last year over one-half was due to hiring technicians to run the ROVs.

This update of the manned submersible field is based on two previous articles in *Sea Technology*. One was the exhaustive "An Overview of Submersible Activities Worldwide in 1977" by R. Frank Busby on page 15 of the January, 1978 issue. Busby has become the leading world authority on submersibles. His exclusive review of Russian submersibles appeared in *ST* for July, 1980, page 18.

The other background article was "Manned Submersibles Still Hold the Upper Hand" in *ST* for December, 1979, page 10. Much of the updating material appearing here is taken from a private report prepared by Busby.

Four Classes of Submersibles

In this review there are four classes of vehicles noted:

- One-Atmosphere (Free-Swimming) Vehicles. In these the occupants are at one atmosphere. They are self powered and untethered. They include the well-known *Alvin*, *Pisces* series and the Perry-built PC series. An exception is the OSEL Group's *Mantis*, a one-man vehicle powered by a surface tethered cable.
- Observation Work Bells. Occupants are at one atmosphere pressure. They are either self-powered or supplied through the tether.
- Atmospheric Diving Suits. Occupants are at one atmosphere pressure, powered either by humans or external power. They are anthropomorphically configured and offer manipulative dexterity. JIM, *Wasp* and *Spider* are in this category.
- Lockout Vehicles. In these one section is always at one atmosphere pressure. A second section can be brought to ambient pressure to lock-out and lock-in support divers. They are either self-powered or receive power from a surface supplied umbilical. Typical of these are the two *Johnson-Sea-Link* vehicles, a Perry PC series and *Shelf Diver*. Included in this category is the *Mobile Diving Unit*, a hybrid vehicle and an observation/work bell.

Two-Year Numbers Growth

In all categories of vehicles the number has risen from 103 worldwide in 1978 to 133 in mid-1980. One-atmosphere vehicles rose from 62 to 69, observation and work bells from 7 to 13, one-atmosphere diving suits from 12 to 23 and lock-out vehicles from 21 to 28.

The greatest increases are in the observation/work bells and the atmospheric diving suits. This is attributed to their greater manipulative dexterity and maneuverability over vehicles that can range over wider areas.

More countries are operating manned vehicles. In 1978 there were 11 countries. Now it has increased to 15. The new countries are Yugoslavia, Norway, the People's Republic of China and Rumania.

Since the 1978 report 11 vehicles have been taken off the list because they are no longer in service or have not dived in the last two years or were never funded for construction. They are the *Asherah, Sea Ranger, Sea Explorer, Neree, Tetis, Skadoc-1000, Moana I, OSA-3, Opsub, Johnson-Sea-Link III* and *MOB 1003/1004*.

Dominant Constructors Change

In 1978 the dominant nations in construction of manned submersibles were the United States and Canada. But in the two years since then France and the United Kingdom have come to the fore.

Canada

In Canada the observation and work vehicle *Arm IV* has been constructed, completed in July 1980. The builder is Can-dive Services Ltd., North Vancouver, B.C. Canada's biggest producer, Hyco Ltd., was placed in receivership in 1979 and manufacturing halted. Hyco's facilities were taken over by Canadian Underwater Vehicles Ltd.(CUV).

CUV has been selected by the Soviet Union to build the 6,000 m depth capability *Akademik* by the Institute of Oceanology of that country. *Akademik* will feature a titanium hull furnished by the Soviets and hydrazine gas system for forcing out liquid ballast, for the variable buoyancy control, driving turbines for power and furnishing heat for the vehicle. CUV will also construct three 6,000 m depth capability ROVs for the Russians.

France

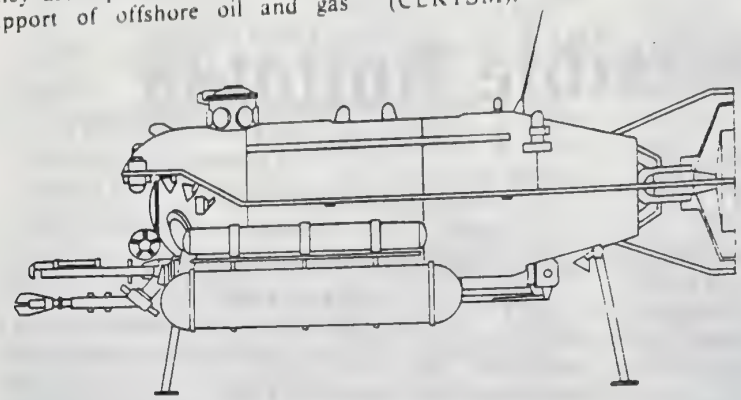
In France Comex Industries Marseille, has built three diver lock-out submersibles. They are the SM-351(2) and the SM-360. SM-351(1) has been delivered to a Rumanian institute devoted to underwater

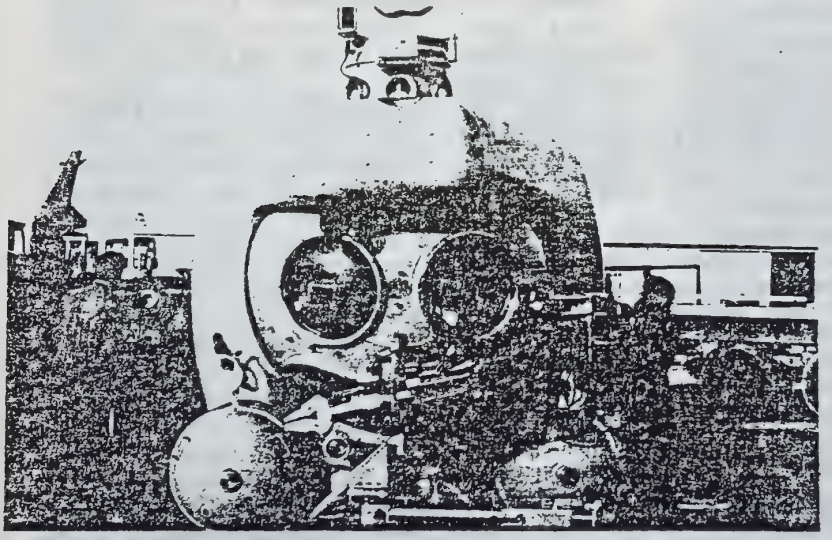
research. SM-351(2) is being delivered to the People's Republic of China(PRC). PRC will take delivery of the SM-360 by the end of the year. They are reportedly to be used in support of offshore oil and gas activities.

Another Marseille firm, Services et Activites Sous-Marine(SAS), completed the vehicle *Sea Cat* in 1979. It is being employed in undersea survey work.

The government Centre National Pour l'Exploitation des Oceans (CNEXO) has completed design for the 6,000 m depth submersible SM-97. It will have a titanium hull. Its mission will be in support of scientific research by CNEXO. Testing of a titanium hull prototype hemisphere was due to be completed by the end of this year.

Also due to be completed by this fall was the lock-out submersible *Licorne*. The 300 m vehicle was built by Centre d'Etudes et de Recherches Techniques Sous-Marine—(CERTSM).





SM 358 diver lock-out, lock-in, submersible developed by Comex Industries, Marseille, France, front view and side schematic view. It can perform observation missions to 300 m with a pilot and observer; conduct atmospheric transfer operations on sea bed production facilities down to 300 m using a special skirt; and with one pilot, one observer, one bellman and two divers can operate for four hours bounce diving down to 100 m with pressurization of diving compartment, or two man-hours saturation diving to 200 m with pressurization on board the ship.

Italy

In Italy two observation work vehicles have been produced by Drass of Zingonia for Sub Sea Oil Services, Milan. The first, the AWOC 650, is operational. The second, the AWOC 300, was due to be completed this year. The Italian Navy is sponsoring construction of a submarine rescue vehicle designated the SM-1. It is to be built by Cantiere Navel Vrede, Venice.

Sub Sea Oil Services is pressing a development program it calls PH-Phoenix. The main feature will be a closed cycle diesel engine to furnish power. The PH-1 would be a short range diver lock-out submersible, the PH-2 medium range submersible and the PH-3 a long range submarine. A submarine is defined as capable of independent operation.

The PH-1 will operate in conjunction with a saturation diving system installed on a tender vessel which would also support the sub during operations. It would have a maximum lock-out depth of 500 m. Its capabilities would be complete diver support such as helium-oxygen breathing gas, heat, water, food and waste bags. It would have four pilot-operators in the one-atmosphere compartment and four divers in the lock-out compartment. In emergency rescue conditions it could accommodate ten divers.

Japan

In Japan the Japan Marine Science and Technology Center (JAMSTEC) has commissioned Mitsubishi Heavy Industries to build the 2,000 m depth, one-atmosphere submersible *Sinkai 2000*. Launching is expected to take place next month. It will work with the support ship *Natsushima*. It will be used for scientific research support by JAMSTEC.

In 1978 the observation/work bell *Tankai* was put into service by Fukada Salvage and Marine Works Co., Tokyo. It was built by Nippon Kokan Kaisha. It is unique in that the upper pressure hull hemisphere is composed of steel and the lower hemisphere of acrylic plastic, thus providing a panoramic view downward. A viewport in the hatch provides vertical upward viewing. Also unique is the use of water jets for propulsion.

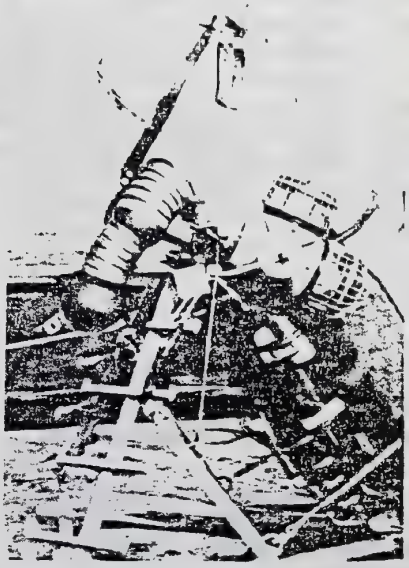
Norway

An observation/work bell *Checkmate* was built by and is operated by A/S Mollerodden based at Haugesund. It is powered through an umbilical and can operate down to 300 m. The spherical pressure hull is composed entirely of acrylic plastic with aluminum inserts at top and bottom for attachment to the exostructure and for through-hull penetrations. Its mission is to inspect and maintain structures and pipelines.

Switzerland

In 1979 a one-atmosphere submersible the *F.A. Forel*, originally designated the PX-28, was

delivered to the Foundation Pour l'Etude at la Protection de la Mer et des Lacs which is located at Cully. Its depth capability is 500 m and carries a crew of three. It was designed by Jacques Piccard and built by Giovanola Freres of Monthey. Operated by the Foundation, it will be used for research.



WASP one-atmosphere diving suit built by OSEL of Great Yarmouth, United Kingdom.

United Kingdom

In the last two years four firms have produced manned vehicles in the United Kingdom. They are: the OSEL Group in Great Yarmouth, Norfolk; Slingsby Engineering, Kirbymoorside, Yorkshire; DHB Construction Ltd., Alton; and Oceaneering International, Aberdeen.

OSEL has constructed four 600 m depth capability *MANTIS* one-man vehicles and is building two more. Unlike other one-man vehicles the *MANTIS* can operate as an unmanned ROV. OSEL also builds the *WASP* a one-atmosphere diving suit. Out of four produced, two have been built in the past two years and two more are under construction. All have been built for Oceaneering International.

Slingsby has produced two one-atmosphere diving suits called *Spider*. They were designed in conjunction with the vehicle operator, Wharton Williams Ltd., Aberdeen. *Spider* is similar to *WASP*. It is powered by a surface connected umbilical and maneuvers by six infinitely varible thrusters. Two extendable suction pads, called "sticky feet," permit it to attach itself to a structure to carry out a job. *Spider* is designed as a system which includes a control van, winch, lift system, cable and the vehicle itself. Thus it can operate from a vessel of opportunity, requiring no dedicated ship.

The best known modern one-atmosphere diving suit, *JIM*, has been built by DHB Construction. Oceaneering International operates those produced so far, with the first one having been deployed in 1974. Today there are 15 operational, with one built in the past two years and another under construction.

The 15 *JIM*s are grouped into four types. Those now operating are the II,III,and IV series whose respective depth capabilities are 457 m, 305 m and 605 m. Like *WASP* and *Spider*, *JIM* is powered by the human operator and lowered on a stage to the working depth by a cable.

In 1979, Oceaneering International and OSEL collaborated to produce the observation/work bell *Arms III*. The earlier I and II versions were constructed by Perry Oceanographics. They operate to 914 m. *Arms III*, unlike the earlier versions, obtains its power from an umbilical cable rather than onboard batteries. *Arms III* has two Perry manufactured manipulators and a General Electric force feedback manipulator.

United States

In the past two years Perry Oceanographics has been the only U.S. constructor of submersibles. Three vehicles were completed: the PC-1602; Mobile Diving Unit (MDU); and Observation Manipulation Bell-1(OMB—1). A second bell, OMB-2 is under construction.

PC-1602 and OMB I were both constructed for Saipem of Italy. That company operates the huge pipelay barge *Castoro Sei* that is laying gas pipelines from Sicily to Algeria, using the services of the two submersibles. For a story on the *Castoro Sei*'s work see *ST* for October, page 14, and an earlier one July, 1979, page 10.

MDU is located in Aberdeen, Scotland, where it is assigned to Occidental Petroleum Ltd. and BP for use in the North Sea.

In other activities in the U.S. since 1978, the U.S. Navy's *Turtle* one-atmosphere submersible has been refitted with a titanium hull that will increase its operating depth to 3,048 m. What was originally a twin vehicle, the *Sea Cliff* is scheduled to be refitted with a titanium sphere that will increase its depth capability to 6,000 m, enabling the Navy to retire the bathyscaph *Trieste II*.

West Germany

In 1979 Bruker Meerestechnik GmbH, Karlsruhe, West Germany completed the *Mermaid VI A* and is building the sister *Mermaid VI B*. Two more, the C and D versions, are being constructed with one due this month and the other next year. They are battery powered and capable of operating to a depth of 600 m. There are three interconnected spherical pressure hulls. The forward one is a one-atmosphere transfer chamber and the aft carries auxiliary equipment. They can dry transfer to 600 m and lock-out to 300 m.

Activities of the Soviet Union were described above in the section on Canadian submersibles.

Trieste Could Not Find RUWS

In June of this year *Trieste II*, owned and operated by the U.S. Navy, dived to 4,572 m off the west coast of the big Island of Hawaii. It was trying to locate the remotely controlled vehicle RUWS (Remote Underwater Work System) that had been lost on a test mission. *Trieste II* found that the bottom was strewn with Trieste size boulders which masked the possibility of locating the RUWS on the CTFM sonar. The mission was scrubbed. There is a possibility that an attempt will be made to make a photo-mosaic using the towed vehicle *Angus* of the Woods Hole Oceanographic Institution.

West German Underwater Vehicles

The West German Federal Ministry of Education and Science, in 1970, contracted with Dornier Systems to carry out a feasibility study of unmanned underwater vehicles for marine research. With requirements of different scientific groups as criteria, Dornier investigated several configurations, the objective being a single vehicle which would have all the capabilities required. Early in the study it was obvious that one vehicle was not reasonable for all the applications proposed. The result of the study was three different vehicles — each with capabilities for specific missions.

The SF O Underwater Vehicle is a controllable unit without a propulsion system. It is towed by a surface vessel with an electromechanical cable which carries power, command signals and sensor signals. The unit may be towed horizontally at a given depth or programmed to follow the seafloor contour at a specified distance by action of adjustable planes.

Basic sensor units installed in a flooded section measure temperature, salinity, sound velocity, pressure, and water depth. A side scan sonar is used for sea bed mapping. Provisions are made to install additional equipment according to mission requirements. The unit weighs 300 kg. in air, and is designed for a depth of 500 meters.

The SF 1 Underwater Vehicle is a tethered body with its own electric-powered propulsion system. For geological and geophysical survey work, and recovery involving heavy equipment and high power requirements, this unit is designed to operate at low speeds. It is a tubular frame to which equipment is attached.

Equipment for the SF 1 includes: manipulator for sample collection with a 24-compartment sample container; cameras and television equipment; a multiple water sampler with STD and sound velocity sensors; a multiple sediment core drill for collecting eight undisturbed samples; and vertical and horizontal echo sounders. Other equipment which can be installed includes: a hard rock core drill for six cores; stereo photo and television equipment; sea gravity meter; acoustic sediment survey instruments; and acoustic seismic instruments.

At the top of the frame are located four fiberglass buoyancy tanks, two variable ballast tanks, and a trim tank. Two propellers provide forward speeds up to 2 knots and a single propeller provides vertical thrust. The unit is designed for a depth of 1,000 meters and weighs 1.9 tons in air.

The SF 3 Vehicle is an unmanned, untethered vehicle with its own propulsion system and power supply. It is designed to operate to a depth of 1,000 meters, with a maximum range of 65 km. at speeds up to 6 knots. At 2 knots, power is available for 18 hours of operation. Basic equipment for the SF 3 includes: sensors for temperature, salinity, sound velocity, and pressure; echo sounders for navigation and depth; multiple water sampler; and camera. Other sensors may be installed.

A fixed propeller provides forward thrust. For stabilization and hover, two swivelled propellers are located on each side and a vertical prop is located aft. The vehicle is positively buoyant. A sophisticated guidance and control system employs an inertial platform, doppler sonar, a transponder navigation system, pressure sensors, echo sounders and an onboard computer.

Shell maintenance and inspection for British Oceanics manned submersibles

Shell Exploration and Production have awarded a subsea maintenance and inspection contract spanning five months to British Oceanics, a member of the British Underwater Engineering Group.

The contract, which is being carried out by the mother ship *British Voyager* and two manned submersibles, the LR3, specially developed for pipeline survey operations and the L5, designed for diver lock out use and modified for the Shell contract, covers Shell Expro's platform installations, loading buoys and pipelines on the Cormorant, Dunlin, Brent and Auk fields and sections of the main FLAGS trunk line.

British Oceanics' two manned submersibles are equipped for the contract with both colour video and stills camera arrangements, cathodic protection and current density measurement instrumentation, trench profilers and the Innovatum pipe tracking systems. The mother ship, *British Voyager*, will use a range of positioning equipment and techniques during the contract period including Pulse 8, Syledis, Motorola Mini Ranger and laser ranging systems with submersible navigation carried out using the Oceano long base line acoustic system and Honeywell RS904 short base line system.

According to British Oceanics, approximately 85% working, including crew change periods and weather downtime, should be achieved by the *British Voyager* and the two submersibles, said to represent the most advanced spread mobilised to date, during the five month contract.

Hawk submersible targeted to work at full ocean depths

THE OSEL GROUP of Great Yarmouth has begun development of a one-man, one-atmosphere submersible vehicle which OSEL believes in two to three years could be capable of reaching full ocean depths.

A $2-million development program is geared to utilize existing technology to extend the current depth limitation of one atmosphere working submersibles from around 2,500 ft while continuing the effort to develop a vehicle capable of working at full ocean depths.

In its development of the Hawk, OSEL is using experience gained in the design and manufacture of over 20 one-atmosphere vehicles, including the Wasp suit, Arms 3 and Mantis. Hawk represents a development from the Mantis which has a maximum depth rating of 2,300 ft.

Hawk is designed to support deep drilling operations and ocean mining. While as a drilling support vehicle Hawk will carry out essentially the same tasks as the existing Mantis submersible, it is very different in design.

According to OSEL, it will have more advanced manipulators than Mantis. This is necessary because it is a larger vessel and the operator is more remote. Capability will be roughly the same.

The Hawk propulsion system will use a cycloidal propeller powered by a single side motor with a back-up. In comparison, the Mantis propulsion system is based on 10 thrusters.

Hawk is designed to operate in either the tethered or untethered modes, enabling it to work completely free, on a light video tether using battery power, from an unpowered garage, or from a powered garage. Without the use of a garage as an intermediate staging post, the need for tethers below 3,000 ft is a severe limitation. Tethers, however, allow the use of real-time video and communications.

The certification limitation on the Mantis is the capability of its acrylic viewing dome. This will be circumvented on the Hawk by the use of ceramic technology. While this does not pose a problem in 6,000-ft water depths, difficulties remain in going deeper. The technology does not exist to establish seals capable of resisting the pressures that will be encountered at 20,000 ft.

In OSEL's view, this problem is far from insoluble. The answer may lie in the field of materials technology. □

PRC Wants Rescue Submersible

During a recent visit of a delegation of Peoples Republic of China scientists and ocean engineers to the U.S. west coast the Chinese let it be known that they were interested in a submarine resuce submersible.

The U.S. has two such vehicles, the Deep Submergence Resuce Vehicles *Mystic* and the *Avalon*. Each one can operate to a depth of 1,525 meters. They are capable of being airlifted in a C-5A aircraft and being carried to the site of a submarine sinking piggyback on a mother submarine. Each has three pilots. By mating with a downed sub each can carry 24 resucees to safety.

The PRC delegation asked whether they could see the DSRVs. After consultation with Navy headquarters in Washington the request was denied. No reason was given, but the best guess is that the two vehicles embody technology that the Navy considers exclusive and shouldn't be divulged to a communist nation.

China Sub Blast

PEKING — An explosion ripped through a Chinese submarine during maneuvers off the north China coast in August, killing between 100 and 200 men, an Asian diplomatic source said yesterday.

Western analysts who had heard the reports, however, discounted the possibility that a submarine accident could result in so many deaths.

But the Asian diplomat said, "We have heard from the People's Liberation Army that there was an accident and there had been some deaths. We heard it was between 100 and 200 men."

USSR focuses on underwater vehicles

The Soviet Union is giving high priority to expansion of its design and development program for manned and unmanned underwater research vehicles.

The latest unit — the 56th device built in the USSR for underwater experiments and projects — is the Okeanolog, which was tested late last year near Novorossiisk at the eastern end of the Black Sea. Carrying a three-man crew, the vehicle reached a depth of 1,998 ft, setting a Russian record for this type of equipment.

According to a Russian account, "The Okeanolog maneuvered and handled well and, when necessary, could hover above a given point. Its arm — an electro-hydraulic training manipulator — securely held a geologist's hammer, scoop, ground pipe for taking samples, and other instruments."

The Okeanolog was developed for use by the USSR Academy of Sciences' Far Eastern Scientific Center.

Other manned submersibles now being employed by Russia include the Sever-2, Shelf-1, Tetis, Argus, Tinro-2, Bentos-300, Atlant-1, and Atlant-2. All differ in terms of size, depth of descent, and self-sufficiency.

The Bentos-300 is said to be "one of the world's largest underwater research vessels." It carries a 14-man crew, has a displacement of up to 500 metric tons, and can operate below the surface autonomously for as long as 14 days.

Russian reports say the Bentos-300 is equipped with a device permitting release of a diver "deep beneath the surface."

The Sever-2 carries a five-man crew. Highly maneuverable, it is designed to reach a depth of 6,562 ft. It is equipped with "five independent emergency ascent systems and an efficient fire-fighting system."

A smaller submersible, the Argus, is being used to obtain information on the earth's crust and continental movements.

About 19.7 ft long, the Argus has a displacement of 8.5 metric tons. It carries a three-man crew, can dive to 1,968 ft, and is able to remain under water for about 8 hours.

Unmanned remote-controlled underwater units include the Crab, Manta-1.5, Zvuk-4, Zvuk-4m, Zvuk-6, and Manta-6. The Manta-1.5 is designed to reach 4,921 ft, the Zvuk-4 and Zvuk-4m about 13,123 ft, and the Zvuk-6 and Manta-6 about 19,685 ft.

Soviet sources say unmanned devices demonstrated their capabilities last year when a Russian expedition analyzed Red Sea rift zones. They enabled scientists to collect samples of Red Sea basalts, take more than 4,000 pictures, and shoot a large amount of television film.

Vyacheslav Yastrebov, deputy director of the USSR Academy of Sciences' Oceanology Institute, states that "a second-generation aqua-robot" will soon be added to his organization's fast-growing fleet of underwater scientific-research units.

Named Skat, this robot is described as unique.

"Unlike other remote-controlled apparatus, there is no cable between the mother ship and the unit," Yastrebov explains.

"All of the robot's movements, depending on the sea floor's relief and the outside circumstances, are guided by a built-in computer. The Skat has a 'memory,' can acquire elementary skills, independently adapt to the atmosphere on the bottom, and take photographs."

Yastrebov calls Skat the "latest rung in the ladder of man's exploration of the ocean depths."

Russia began to make serious efforts at underwater research in 1966 with the Ikhtiandr program. For three successive years various types of underwater habitats were tested along the Crimea's Black Sea coast, and medical experiments were carried out.

Later, other Soviet programs, including the Chernomor project, were devised and implemented by scientists from the Oceanology Institute. □

WRANGLER HULL

SLINGSBY ENGINEERING LIMITED announce that they have completed delivery of the first of the pressure hulls for the new WRANGLER one man submersible, being manufactured by INTERNATIONAL SUBMARINE ENGINEERING of Port Moody, B.C., Canada.

This hull is constructed of glass reinforced plastic (GRP) using the methods that SEL have developed for manufacturing pressure hulls for their own vehicles, both manned and unmanned. It is ABS certificated for an operating depth of 2000 ft. G.R.P. was chosen as the pressure hull material after extensive investigations into other materials had been carried out by I.S.E. Advantages of the material are light weight, freedom from corrosion and low thermal conductivity. The cylindrical hull has attachment points and penetrations moulded in and is closed at the ends by two acrylic hemispheres.

SEL completed the hull exactly 5 months after their engineer visited Port Moody to discuss the design, and the first vehicle is scheduled for delivery to the Canadian Armed Forces before the end of 1981.

Stirling Engine Powers Subsea Closed Energy System

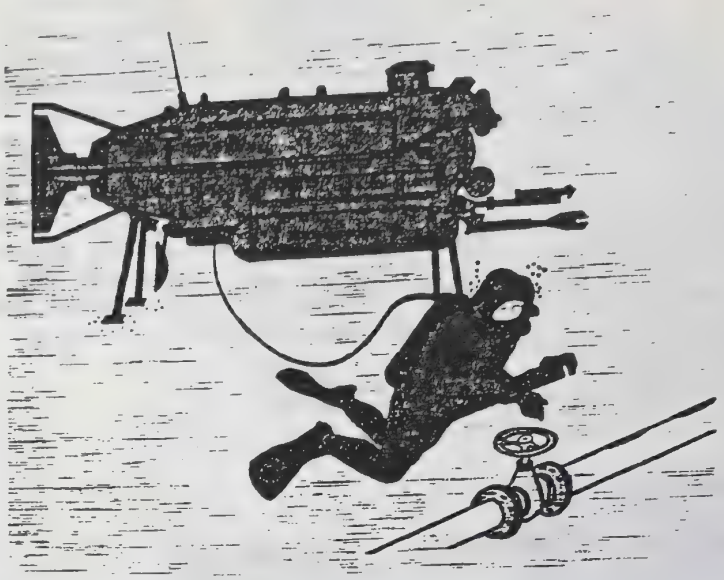
A 25-kW SUBSEA POWER PACK based on a USS 4-95 Stirling engine is currently being developed by United Stirling Sweden (USS) working in collaboration with Comex of Marseille, France. Fuels to be used include diesel oil, alcohols, kerosine, etc., that will be burned with pure oxygen. The oxygen will be stored either as high-pressure gas (300 bar) or as LOX.

The subsea power pack is intended for deep water missions. The combustion system has been specially modified for elevated combustion pressure equivalent to that of the ambient water. This obviates the need for an energy-consuming exhaust gas compression.

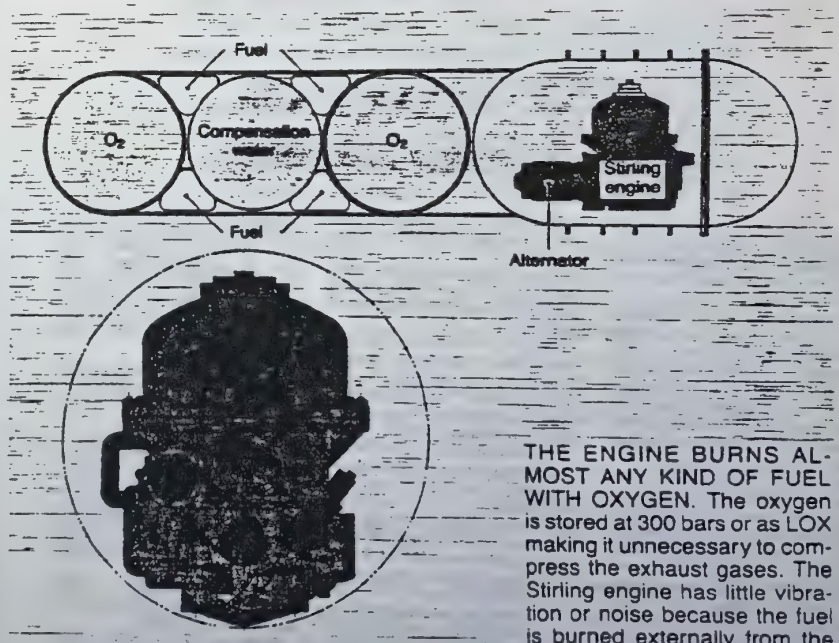
The first application of the power pack will probably be in underwater systems using saturated divers. Maximum operating depth is expected to be around 300 m, which is why the combustion pressure is slightly above 300 bar. The use of an additional exhaust gas compression of only marginal pressure ratio would allow greater operating depths to be reached.

It is likely that the power pack will be housed in a neutrally buoyant pod with a diameter of 0.8 m. For an energy storage of 200 kWh of electric power with an additional hot water supply, the oxygen may be stored as high-pressure gas. The dry weight of the system would be roughly 3 tons, attaining almost neutral buoyancy when submerged. The same technology for pure oxygen pressurized combustion could also be applied to a 75-kW engine, the company says.

United Stirling has been working on the underwater applications of their engines since the early 1970s. Of external combustion, closed-cycle type, the Stirling engine has good fuel economy and can use a wide range of fuels. Other features are low cyclic torque variations and low noise and vibration levels. USS is regarded as a world leader in the development of the Stirling engine. They plan to introduce the 4-95 system next year.



STIRLING ENGINE IN POD WILL SUPPLY ELECTRIC POWER AND HEAT for divers operating in depths ranging to 300 m. The development is being carried out by United Stirling Sweden working in collaboration with Comex.



THE ENGINE BURNS ALMOST ANY KIND OF FUEL WITH OXYGEN. The oxygen is stored at 300 bars or as LOX making it unnecessary to compress the exhaust gases. The Stirling engine has little vibration or noise because the fuel is burned externally from the power cylinders.

Deep Quest

Safer, quieter, more efficient cooling system studied for our deep diving submersible

LMSC will soon begin tests of an efficient new cooling system on board the deep-diving submersible, Deep Quest.

"The new system will be safer, quieter, and more efficient than the conventional Freon vapor-cycle refrigeration systems presently used on some research and rescue submersibles," said Yi-sheng Li, LMSC project manager who designed the thermo-electric system.

The experimental array of hull-mounted heat exchanger and thermo-electric cooling panels is being installed in the Deep Quest and will be tested during demonstration dives planned in San Diego Bay before the end of the year.

Cooling is required to maintain a liveable environment on the small submersibles that must spend considerable time on the surface during operations and are thus exposed to solar heating.

"The system will avoid the conventional refrigerator's problems of noise, vibrations, and possible Freon refrigerant contamination of the submersible interior," said Li. "To meet safety requirements, such a refrigeration unit is complex in construction, difficult to maintain, and requires lots of scarce on-board electrical power," he added.

The difference between the thermo-electric and refrigerator systems is as follows:

A refrigerator works by mechanically compressing the Freon and then allowing it to expand in a closed space so that it absorbs heat which is ejected to the seawater. The necessary equipment includes heat exchangers, compressor and pumps —and all complicate the system.

By contrast, the thermo-electric units have no moving parts, no vibration, no noise and no potential contaminants — such as Freon or oil — and they are simple to design and to operate. They work similar to a thermocouple — only in reverse. When electricity is applied to the thermo-electric module, one side will be hot, and the other side cold, a results of the properties of the materials used.

Further adding to the simplicity of the thermo-electric system: each cooling panel is fabricated so it can be mounted directly to the submersible's interior pressure hull which eliminates a heat transfer fluid and enhances efficiency. Heat is ejected through the pressure hull to the seawater.

The amount of electric power required to operate the thermo-electric units varies with the temperature of the seawater in which the submersible is operating.

Li says an array of cooling panels recently passed all laboratory tests in which they were mounted inside a submerged tank that simulated the curved bulkhead and interior atmosphere of a submersible.

Advanced Ocean Drilling

New venture to provide detailed profile of earth's structure, geological history

The National Science Foundation has selected LMSC to perform a design study to modify and operate a ship for one of the world's leading scientific programs during the next decade.

Called the Advanced Ocean Drilling Program, the venture will consist of obtaining earth cores using a drill string that will stretch for more than six miles from the ocean's surface and penetrate its floor.

Obtaining such corings from submerged land masses — corings that will sample the earth's composition as deep as 20,000 feet — will give geoscientists a new, detailed profile of the structure, geological history and resources of land volumes heretofore inaccessible to man.

LMSC will assist in planning and conducting the proposed nine-year Ocean Drilling Program. Drilling sites, being considered, are on all three U.S. coasts, the mid-Atlantic ridge, off the Moroccan coast and in the Weddell Sea of the Antarctic.

Two coring platform alternatives will be examined. One will be to determine if an existing drill-ship can be suitably modified; the other, to consider the reactivation of the Glomar Explorer, a 30,000-ton, 618-foot, government-owned vessel.

Sedco, Inc., Dallas, Texas, a company with extensive experience in worldwide marine drilling, will work with Lockheed Ocean Systems engineers on the project.

LMSC program manager Bill Perkins said plans to modify a drill ship and choose a shipyard for modification and fabrication will be completed by mid-1983. Simultaneously, the ocean floor site survey, and geological/geophysical planning data also will have been completed. If the Glomar Explorer is used, an estimated 14 months will be required to modify and provision the ship and conduct sea trials before beginning the drilling program in 1985.

Diving in to trouble

THE LACK of regulations for one-man submarines working in the North Sea is worrying the joint MPs/trade unions North Sea working group.

For they say too much control is being left to the Association of Diving Contractors, the employers' organisation.

"We are very alarmed at the situation and will be keeping a close watch on it," said Labour MP John Prescott, the union/MPs group chairman.

The group have already drawn up a charter of rights, for all North Sea workers.

There are no safety rules for one-man submersibles, which can operate below the depths where a rescue bell could reach.

Draft rules for the use of one-man submersibles were at the Department of Trade earlier this year.

But the Association of Diving Contractors say the draft legislation will be accompanied with a code of practice drawn up by the association.

This will not be ready until April or June. And they deny that they are drawing up the code and influencing the legislation to suit themselves.

AODC FORMS SUBMERSIBLE SUB-COMMITTEE

At a recent meeting, the UK Association of Offshore Diving Contractors' Council decided to form a submersible sub-committee.

Most of the manned and unmanned submersibles being operated in the North West European continental shelf area are by AODC members. The Association knows that new regulations on design and construction aspects of manned submersibles will be issued in the UK in 1982 and that similar regulations are under consideration in Norway.

AODC members, clients, third parties and government officials have expressed degrees of concern on certain aspects of the operation of submersible machines, ranging from mobile bells through one-atmosphere suits, to free swimming submersibles, including diver lock-out types.

The Council felt, therefore, that as the relevant trade association, it should take a closer interest in common problems relating to this aspect of the industry in order to be able to present an informed and common front on pertinent matters as and when required.

While the new submersible sub-committee will, in the main, concern itself with operational, design, construction and survey aspects of manned submersibles, it will as appropriate consider relevant aspects of unmanned submersibles if these are deemed to be in the interests of the industry as a whole.

In common with other AODC sub-committees, this new submersible sub-committee will report to the AODC Council through its convenor, who will be Dan Walker of International Underwater Contractors Ltd, Dyce, Aberdeen.

Contact: Tom Hollobone, Secretary of the AODC on 01-405 7045.

Compressed Gas Assoc. Warns Divers of Possible Oxygen Tank Ruptures

Because of several recent incidents involving the violent failure of oxygen cylinders in offshore diving operations, companies belonging to the Compressed Gas Association (CGA) have undertaken a study to determine possible causes. The results of the study show that the ruptures occurred because of mishandling by the users. Seawater was allowed to flow back into the cylinders after the oxygen in the cylinders had been depleted.

The CGA safety bulletin states that metallurgical studies show that "seawater in a standard DOT 3A or 3AA oxygen cylinder will cause extremely rapid corrosion to the extent that the cylinder will fail violently within 30 to 60 days, (depending on the oxygen pressure in the cylinder).

The CGA also says that the cause of the ruptures lies not only with the user but also with the producer who transports, handles and refills the cylinders. The CGA recommends the following additional safety precautions:

1. If at all possible, do not attach an oxygen cylinder to a submersible or allow an oxygen cylinder to be submerged. If the user operations do not allow this recommendation to be followed: when a cylinder has been submerged, the user should paint SUBMERGED down the side of the cylinder before returning it for refilling.

2. In the case of a cylinder or cylinder bank that is kept on the surface and is used to supply oxygen to an underwater operation: as the cylinders are emptied, do not allow the residual pressure in the cylinder or cylinders to fall below two times the equivalent seawater pressure at the depth where the oxygen is being used.

3. Never transfer oxygen from one cylinder to another without the permission of the owner of the cylinders. Federal law prohibits the transport of cylinders filled without the owner's consent.

Mantis Incident Summary - Subsea Dolphin A/S

A few weeks ago there was a diving incident on the Dyvi Delta, involving a Mantis 007 operated by Subsea Dolphin. A brief summary follows:-

At 1600 hours, Pilot J. Anderson (29 yrs.) a junior pilot with 30 hours experience (3 months with S.S.D.) Depth 350 ft. Supervisor Karl Klofjeld. During the dive the Mantis umbilical became trapped under the base plate, and the sub slipped into a 6ft deep scour hole, while trying to untangle itself. Viz zero.

When the viz cleared, the umbilical was seen resting over the front dome, and a manip was used to free it. However on manoeuvring the sub, it was still found to be trapped. At this stage, Statoil instigated their emergency plan. The pilot had now fallen asleep, and became very difficult to awake. When he was at last roused, and told to put his lights on, both lights failed (1 x bulb failure, 1 x EO pulled out)

At 0300 hours, the RCV Filipo was launched and followed the Mantis umbilical, taking video. The sub was found to be 270° around the stack under the base plate, and in the scour. The RCV moved towards Mantis, and then guided the sub back around the stack and out of the scour.

1025 hours Mantis on deck/hatch open/dive ends.

New Hyperbaric Research Facility Dedicated. On July 1, 1981, the U.S. Navy's Hyperbaric Research Facility was dedicated at the Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland.

The Hyperbaric Research Facility is the Navy's deepest diving facility with a capability of simulating depths equivalent to 3,400 feet of sea water.

The Navy's needs for a deeper, longer diving capability requires bio-medical support to provide critical information regarding the physiological and psychological capabilities of the diver for safe, productive diving.

The Hyperbaric Research Facility will be dedicated entirely to research in hyperbaric medicine and physiology and is the Navy's lead facility in this field. As part of the Naval Medical Research Institute, personnel of the Hyperbaric Research Facility collaborate with other NMRI staff in all phases of medicine and physiology related to hyperbaric research.

Rear Admiral D. M. Smith, Director of the U.S. Navy's Deep Submergence Program will officiate at the ribbon cutting. The facility will be dedicated in the name of Captain Albert R. Behnke, Jr., MC, USN (Ret.). Dr. Behnke was a leader in Navy diving for many years and served at the Naval Medical Research Institute during World War II as Officer-in-Charge of NMRI's Experimental Diving Unit.

Manipulator Bell Rescues Submersible In 1,700-ft Water

SAIPEM S.p.A. has revealed the dramatic rescue of a two-man submersible by an observation manipulator bell (OMB*) during work on the Trans-Mediterranean pipe line.

The *PC1602* submersible became entangled and was disabled in about 1,700 ft of water while conducting a survey of the pipe line on Nov. 14, 1980.

"Transmissions from the sub informed us that the propeller was entangled and inoperable," says G. Melegari, supervisor for Saipem, owners and operators of both the submersible and observation manipulator bell.

Minutes after being notified, the status of the submersible's life support supplies was ascertained and a crew was assigned to prepare and mount the needed cutting tools to the manipulator arms of the OMB. To better coordinate the operation, the disabled sub's topside controls were moved from the operations control room to the OMB operations control room.

The rescue operation—from OMB launch to recovery of the submersible—was completed in little more than one hour, according to Melegari.

The incident, according to company spokesmen, demonstrated foresight on the part of Saipem in the development of the Ragno Due subsea support spread. Jon P. Newman, vice president of Perry Oceanographics, Inc., manufacturers of the OMB and *PC1602*, says this planning included not only routine subsea operational considerations but rescue considerations.

"One of the primary subjects of our initial discussions with Saipem was their interest in the potential rescue capabilities of each vehicle," says Newman. "It is evident that the planning paid off."

The following chronology of the rescue was issued by Saipem supervisory personnel:

LOG OF KEY EVENTS

4:46—*PC1602* launched for dive to survey pipe line.

6:40—Sub moving along pipe in 1,740 ft of water. Measured free span existing under joint 4002. Sub ready to move further.

7:10—Message from sub indicates it apparently is entangled on the bottom and cannot move. Further messages to inform surface that coupling between gear box and shaft seal is broken.

7:12—At surface, pilot and co-pilot for OMB advised to be ready in 15 minutes for pre-dive briefing. Mechanical staff advised to prepare cutting wheel and related hydraulic tool for installation on OMB. Evaluation of life support supplies on sub. Crew advised on best oxygen level and how to save electric power. Surface supervisor moves controls from sub control room to OMB control room. Underwater telephone transducers from OMB control room deployed for communication check with sub (OK). Ship master informed. Ship moves to position on top of sub and keeps position by dynamic positioning. Messages between sub and surface evaluate situation. Steel cables, including a guide line to be used as reference during pipelaying, are in area. No exact evaluation possible. Entanglement due to steel cable or soft line.

7:28—Pre-dive briefing in OMB control room. OMB pilot and co-pilot informed, advised to prepare OMB with hydraulic cutting wheel, sharp knife on advanced manipulator, extra knife ready for use.

7:40—Sub trying to come up on empty trim tanks. No further movement possible. Sub advised to remain on standby with minimum power on.

8:10—Pre-dive checks completed on OMB.

8:20—Surface supervisor and deck officer in OMB control room with double communication system (hard wire communication system for OMB, wireless communication system on 27 kHz for sub and OMB).

8:25—OMB launched.

8:40—OMB at 1,000 ft *PC1602* turns on lights.

8:46—OMB at 1,680 ft in sight of sub lights.

8:59—OMB getting closer to stern of *PC1602*. Soft line noticed. It is fouled around propeller and other end is connected to a drum filled with concrete and stones. Between sub and drum is pipe line. The drum has been dragged on the bottom 20 to 25 ft.

9:20—OMB is positioned exactly near stern of *PC1602*. TV signals are regularly received at surface. Surface control room authorizes short talk between OMB and *PC1602* on wireless 27 kHz. After evaluation OMB is asked to get ready to cut line with knife installed on manipulator jaws. Line is tensioned between sub propeller and drum.

9:31—OMB ready to cut line.

9:32—*PC1602* crew informed to fill trim tanks with water.

9:33—Soft line severed by OMB.

9:37—OMB leaves bottom. *PC1602* keeps position on standby.

10:06—OMB recovered. *PC1602* still on standby on the bottom.

10:07—Transducers for wireless communication system in OMB control room recovered. Communications and controls for sub moved back to sub control room. Ship moves to better position for recovery of sub.

10:15—*PC1602* leaving bottom on trim tanks only. Pilot ordered not to use any propulsion.

10:48—*PC1602* at surface.

10:56—*PC1602* recovered. On aft deck of ship.

Bruker's latest

The Mermaid IVA, the latest runner to appear from the stables of Rheinstetten-based Bruker Meerestechnik, may be set to become one of the all-too-rare submersible success stories. Its strengths are claimed to be:

— High payload of about one tonne

— Relatively modest displacement (for a big DLO sub at any rate) of 20 tonnes

— Maneuvrability and suitability for diver support tasks

— A big rescue capacity of up to ten men

The first Mermaid IV completed acceptance trials last summer. Amongst the training exercises that followed were successful docking maneuvers carried out on a German Navy conventional submarine.

The first Mermaid IV is now in use, and two others are under construction, and negotiations for a similar submersible with a somewhat larger capacity are now in their final stages.

U.S. Navy Develops Diver Electrical Safety System

Staff Report

In the past, safety considerations for divers using electrical equipment in the severe operating conditions of the open ocean has restricted Navy divers to large, heavy, low-voltage battery-powered systems, or hydraulic systems—both of which are often unwieldly and inefficient. These restrictions have prompted the U.S. Navy to develop an electrical safety system that may make the use of high-voltage, diver-operated underwater construction work systems possible.

The Civil Engineering Laboratory (CEL), Port Hueneme, Cal., has built and tested a ground fault detection (GFD) and power shutdown system capable of removing power from a 440 volt, 3-phase load within 10 milliseconds. Systems rated up to 100 kw have been built and tested. According to the Navy, the system's circuit design philosophy and operational sequence make the use of electrical power by divers much safer.

In normal operation, the ground fault monitor (GFM) applies a positive DC voltage to the delta-connected secondary of the power transformer. The negative side of the DC supply is connected to ground (cable armor, seawater).

If a breakdown in the insulation resistance of the cable or load occurs, a small DC current will flow from the supply. The DC current level is monitored and if it exceeds a predetermined level, a signal is sent to open the circuit breaker. This signal is also delayed 5 ms and used to turn on a set of triacs which short the secondary of the isolation transformer. The triacs also provide a low impedance path to dissipate the stored energy in the load circuit.

The shutdown from the time the DC current exceeds the set point until all power has been removed is 10 ms. If for some reason the circuit breaker does not open, the short circuit currents from the triacs will cause the line fuses to blow and shut down the power.

The integrity of the DC circuit is monitored by a 10 kHz signal. The system automatically shuts down if the signal fails, when an open circuit develops, or when an internal component of the equipment malfunctions.

To make the technology readily available for divers, CEL has developed a portable GFD package, weighing 22.5 kg and measuring 18 x 20 x 28 centimeters. This system can safely transfer up to 2.5 kw at 120 VAC for powering lights or inspection equipment.

In addition to the GFD system, a laboratory model of an underwater electric field detector was built and tested. It can be used by the diver to detect stray fields originating from power systems not equipped with GFD, powered cathodic protection systems or other underwater electrical equipment.

The field detector senses a voltage gradient across three pairs of electrodes exposed to the water on the end of a handcarried probe. A signal proportional to the voltage gradient is compared against a preset level. If the level is exceeded, a warning is sounded. The device is capable of detecting electric fields as weak as 0.12 volts per foot. The alarm circuit output of the detector could be used as an input signal to the GFD system to induce an immediate shutdown of the power load.

The Navy sees many possible underwater applications for the two new developments from CEL including electrically-powered submersibles and rescue chambers, seafloor vehicles powered to greater depths, diver tools using seawater as a medium and driven by submerged electrically-powered seawater pumps and multi-kilowatt lighting systems to enhance diver capabilities.□

ELECTRICITY UNDERWATER

Electricity is an ideal source of power for many applications underwater, but its use has been limited to date because of a natural concern about safety and reliability. Both these fears, however, can be overcome by good design, careful selection of materials and the correct use of equipment.

Authoritative guidance on these matters will shortly be available in the form of a Code of Safe Practice for the design and use of electrical systems underwater. It is being drafted by ERA Technology Ltd on behalf of the UK Department of Energy.

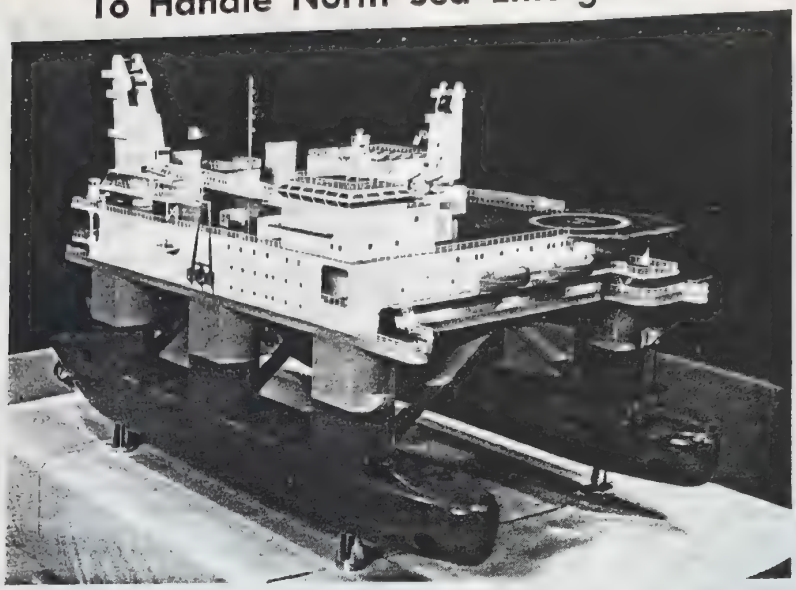
The preparation of the Code is being monitored by two committees consisting of representatives from the Association of Offshore Diving Contractors, the UK Offshore Operators Association, British Electrical and Allied Industries Manufacturers Association, Underwater Engineering Group of CIRIA, Health and Safety Executive, Certifying Authorities, Experimental Diving Unit and the Department of Energy.

Early drafts of the Code were sent to companies involved with the offshore oil and diving industries and their comments have been incorporated in a provisional version, copies of which are available from the Utilisation Department at ERA.

The Code deals with both the design and use of electrical systems underwater and is, therefore, of importance to a large section of the offshore industry, including installation manufacturers, equipment suppliers and diving contractors. It deals with hazards arising from electric shock, toxic fumes from overheated electrical insulation, and the initiation of fire and explosions from electrical apparatus in diving bells, habitats, chambers and submersibles.

Contact: M. Bradford, Utilisation Dept., ERA Technology Ltd., Cleeve Rd., Leatherhead, Surrey, UK. Tel: (03723) 74151 Ext: 380.

Multipurpose Semisubmersible Built To Handle North Sea Emergencies



Model of BP/BNOC emergency support vessel Iolair.

The emergency support vessel (ESV) Iolair, built by Scott Lithgow Ltd. at Greenock on the Clyde for British Petroleum Ltd. and the British National Oil Corporation, is undergoing extensive sea trials before final fitting out and service in the North Sea.

Of a semisubmersible construction, the Iolair is a new design of an ESV and incorporates the best marine components in a complex design first put onto paper five years ago. Launched in April and now undergoing extensive sea trials, she is designed to provide a fire-fighting — including well-kill — capability as well as the diving, maintenance, construction, and accommodation facilities.

A four-deck platform 76.5 meters by 51.5 meters (about 251 by 169 feet) sits atop six columns connected to identical-twin pontoons.

The $120-million Iolair was initially designed as a support vessel in the mid-70s. However, following the Ekofisk blowout in 1977, an emergency role became the prime consideration.

The Iolair will be available to attend an emergency outside the North Sea Forties and Thistle fields which it will patrol for the joint owners.

Her operational displacement of 19,600 tons is lighter than any comparable vessel currently in operation. This, together with a lack of any horizontal bracing between columns or pontoons, gives her a transit speed of 12.5 knots, enough to outstrip any other ESV. Bracing is provided by inverted Vs running from column base to mid-platform. Any single bracing member can be lost without affecting capability. Transit draft will be no more than 6.9 meters.

The 102-meter-long pontoons (about 335 feet) contain fuel, water and ballast compartments, as well as pump and motor rooms. Each of the two after motor rooms houses two 2.42-mw Laurence Scott 6.6-kv electric motors that drive the propellers and a 1.5-mw motor for driving a thruster. The forward motor rooms house a 1.5-mw thruster motor and a 2.42-mw motor driving a fire pump through a variable speed fluid coupling.

The six 6.6-kv Laurence Scott generators are powered by six 3.4-mw German-designed M.A.N. diesels built under license in Britain by Harland and Wolff, Belfast. They are situated in two separate engine rooms on the platform itself and are provided with a switchboard arrangement which, by separating them into three sections, gives a double fall back in an emergency.

At the heart of the Iolair's ability to function in an emergency and support role to rigs and platforms in the North Sea is her dynamic positioning system. The system, supplied by Kongsberg of Norway, uses three computers to control the main SMM propellers and the four SMM lateral thrusters which are positioned transversly in tunnels in the fore and after ends of each pontoon.

The system, which enables the ESV to hold position continuously in high seas, also can be used in conjunction with four anchors deployed one from each corner of the platform.

The Worthington Simpson firefighting system incorporates 16 Knowsley monitors. The vessel is capable of pumping 10,200 cubic meters of water an hour onto a blazing rig 180 meters distant continuously for at least 21 days before having to bunker more fuel. During that time the Iolair would keep her own area cool by showering her total surface area with 5,500 cubic meters of water per hour.

For a top-kill exercise, bulk mud powder permanently stored in four 40-cubic-meter silos in each corner leg would be mixed onboard with chemicals and then pumped at pressure into the well of a striken rig via a telescopic emergency gangway located at the starboard aft-corner of the vessel.

This gangway also will land or evacuate rig personnel. There is a small ward and fully equipped operating room onboard. Specialized medical personnel will be flown to the ESV when required. During emergency operations, all nonessential crewmen will be lifted off.

The platform deck accommodates a helicopter hanger and landing pad, the view around bridge, a small workshop and two cranes. Both—one capable of 40-ton and the other capable of 100-ton loads—can be used through a moon pool in the platform structure.

For heavier work, strongpoints beneath the moon pool allow the Iolair to lift 500 tons up to three meters off the seabed through her own buoyancy. Her operational draft of 15.25 meters will put the platform 17 meters above sea level while work is taking place.

An integral diving center provides facilities for up to 22 divers employed in both surface work (up to 50 meters down) and saturation diving (to 300 meters down).

Living and sleeping compression accommodation for up to six divers allows saturation work to be undertaken continuously through a bell lowered down a tube in the center starboard column.

Tethered manned submersibles The end of the beginning not the beginning of the end

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During the last few years the use of unmanned vehicle technology in offshore work has increased dramatically. Diving companies which were formerly solely concerned with the use of divers have introduced remotely operated vehicles into their sphere of operations either to assist or replace divers, particularly in deep water. Despite their attractions very few of the current generation of submersibles can truly be said to have replaced the manipulative dexterity of divers. In parallel with the growth in the use of remotely operated vehicles, atmospheric diving systems and tethered manned submersibles have gained increasing penetration in the offshore rig support market. The rate of increase of usage has been less dramatic than that in the ROV market but none the less the approximate total number of A.D.S. and T.M. subs, is now 45. The contract utilisation of these vehicles, certainly in the case of those with which we have been associated, is 95% as of today. We have included the Jim in Table 1 since it clearly belongs in the same family of submersibles, representing the simplest unit and thus probably the most reliable.

From Table 1 it can clearly be seen that the most dramatic areas of growth have been at the smaller end of the scale. In terms of relative size Jim and Wasp are roughly the same volume and weight; Mantis, Spider/Omas and Wrangler are also approximately equal in size. We anticipate that the total number of Mantis in operational condition at the end of the year will be 15 and approximately 11 or 12 Wasps. The number of Jims will increase to 20. At this time the production plans for Spider, Omas and Checkmate are not known. The list is not necessarily exhaustive but should be representative of those systems in common commercial use.

TETHERED MANNED SUBMERSIBLES AND A.D.S. UNITS

Table 1

Year of Introduction to Offshore Commercial Use	Manufacturer	Units in Operational Condition Feb. 1981
1974 — Jim	D.H.B./U.M.E.L.	18
1978 — Arms Bell	Perry, O.S.E.L., Can-Dive	4
1978 — Mobile Observation Bell Units	Comex, Drass, Perry	5
1978 — Wasp	O.S.E.L	7
1979 — Mantis	O.S.E.L.	10
1980 — Spider/Omas	Slingsby Eng. Ltd.	2
1980 — Checkmate	Møeller-Rodden	1
1981 — Wrangler	I.S.E.	? } Projections
1982 — "OSEL X"	O.S.E.L.	2 } Projections

Table 2

	Cumulative Totals	
1974	3	
1975	5	
1976	7	
1977	9	
1978	17	
1979	24	
1980	38	
1981	56 } Projections	
1982	75 } Projections	

The use of Bell derived systems will continue to increase, but probably not as rapidly as the lightweight systems. This is because of a variety of reasons; the large systems take longer to build, require more deck space, and are more costly than the lightweight systems. One area of growth which has not been widely exploited is the conversion of saturation diving bells to atmospheric units. This can be achieved very quickly, at reasonable cost, and utilises redundant or written-off equipment. One major psychological advantage cited by users is the use of two men, although in the authors' opinion they may be illusory. One of the most interesting developments in this field is the introduction of partial or complete remote control systems, as an add-on option. Even the most dedicated user of manned systems may find circumstances of difficulty or danger where the potential for use unmanned is vital to success.

System Capabilities

Many of the systems listed in Table 1 have complementary and indeed competitive capability. They share one common objective in that they have all been designed for use in the supporting of drilling rig operations and nearly all of them have been used, at some stage, in that mode. Without exception, however, the successful use of any of the systems requires detailed, specific and extended training. In some cases this training can be carried out offshore but it is generally most beneficial to have a sheltered work site available.

Table 3 shows a typical range of tasks using Wasp and Jim and Table 4 a similar detailed list for Mantis. No doubt similar tooling for such tasks is used with Arms Bells, mobile observation units, etc.

System capabilities are not, however, solely dependent on adding to the range of tools that can be used with each system but on the level of expertise of the operator. The better the operator the more capable the equipment appears to be. This is well illustrated by an operator's use of Wasp. At that time his traiining procedures were very specifically directed to the use of Jim. The Jim pilots had become accustomed to working a stage around the well head which gave very firm support in the form of a reaction surface to turn valves, etc. The pilots' first experience of using Wasp was very disappointing and combined with the relative lack of equipment capability with the early production units, since rectified, produced a negative attitude to their use. Yet, less than a year later the self same pilots were full of praise for the Wasp, as they had become accustomed to working in a different mode.

Wasp has been used exclusively by one operator who also operates Jim. This operator has gained extensive experience offshore with an unblemished safety record. The use of Wasp/Jim combinations has been particularly powerful. The dexterity of the articulating limbs, the very

Table 3
Wasp and Jim Tasks and Toolings

Task	Tooling
Guidewire installation	Regan & Vetco Overshot Cameron Spear Shackles Safety Hooks & Pinch Plates etc.
Corrosion Cap Fitting/Removal	Standard Hydraulic Quick Connects Standard Slings etc.
Master Valve Changeout	Impact Wrench Hydraulic Ratchet Wrench Nut Runner Standard Hand Tools with Handles to suit Wasp
Valve Corrosion Cap Removal/ Replacement	Impact Wrench and Specially designed Socket
Valve Operation	Impact Wrench or Hand Ratchet and specially designed Sockets
Removal of Bushes from Guide Post	Custom made Extractor
Cleaning Bulls Eye	Cleaning Mop
Placing Explosive Charges	Custom made Charge
Recovery of various Debris, Tools and Equipment	Standard Slings, Strops, Shackles and Safety Hooks
Cutting Guidewires	Intensifier and various Cutting Heads
Collection of Gas Samples	Inverted Funnel on Stand
Collection of Cement/Mud samples	Custom Scoop
Measurement of Pit Depth on Anodes	Custom made Tools
A.X. Ring Changeout	Buoyancy Devices and Custom made Clamp
Inspection and N.D.T.	Standard Video Stills and N.D.T. Equipment

small size and the weight of the total package, the application of a sophisticated tether winch to aid operations, combined with the simplicity and ease of servicing have all contributed to this success. There are, however, limitations to their use; the smaller the submersible the less its pay load, in general, and Wasp is no exception. The use of a video camera integrated with the Wasp umbilical cable has taken up some of the excess pay load of the vehicle. In the case of Jim, its co-operation with the rig operator is necessary since a walkway needs to be erected around the BOP stack prior to installation.

The Mantis combines the manoeuvrability of Wasp and the stability of Jim in one unit. It has in addition increased pay load available, and has currently been fitted with a wide range of instruments.

On the debit side Mantis weighs twice as much as Wasp although still only 1.35 metric tonnes and at the moment it does not have the same dexterity as Wasp or Jim. However, from an operator's viewpoint it has performed equally well offshore. All three of these systems, Jim, Wasp and Mantis, use basically the same type of highly evolved, rugged and reliable winch design. This design has managed to achieve functional complexity without operational unreliability or difficulty in setting up. The Mantis in particular also uses a simple reliable docking mechanism/ sheave which enhances the capability for working off ships of opportunity with non-specific handling systems such as ships' cranes or derricks. It is probable that Spider and Wrangler offer the same capabilities.

The performance of the lightweight systems with which we have been associated has now reached the stage where the reliability and task performance allow operators to guarantee results on drilling rig support. These systems have been used for fixed platform inspection and wreckage search. In these modes their performance has been adequate but particular attention to cable handling is essential. The problem of entering fixed structures safely has been dealt with in previous papers (Ref. I). Suffice it to say the safety record of these systems has been so far unblemished.

Table 4
Mantis Tasks and Tooling
As developed to support drilling and rig survey operations

Task	Tooling
Guide Wire Installation	1. Special tool developed to enable Mantis to push out old bullets and refit replacements. 2. Tool developed to enable old bullents to be knocked out of Guide posts, used with surface assistance. 3. Ability of Mantis to fit and remove Shackles.
Valve Operation	1. Mantis can usually complete this task without special tooling. 2. Wrenches available if valve operation proves to be particularly stubborn.
Removal of Bushes from Guide Posts	1. Custom made Extractor.
Cleaning Bulls Eye	1. Water blaster from manipulator pump. 2. Use of mop or similar in conjunction with manipulator.
Placing Explosives	1. Custom made charges — used in conjunction with explosives expert.
Recovery of Debris etc.	1. Standard strops, shackles, hooks etc., combined with on site manufactured equipment as required.
Cutting Guide Wires	1. Hand operated cable cutter, generation 10,000 p.s.i. 2. Special grapple hook, to enable surface assistance if required.
Collected Gas Samples	1. Custom made samples.
Collecting Mud/Cement Samples	1. Custom made samples.
Thickness Measuring	1. Thickness measuring probe — ultrasonic Baugh and Weedon probe.
Cathodic Protection	1. Morgan Berkley C.P. Probe fitted.
Stills Photography	1. Subsea 1000 Camera.
Video	1. C.M.8 Black and White Video Camera as standard (U.D.I.) 2. All boats fitted out to take colour Video to customer requirement. 3. Surface monitor and V.C.R.
A.X. Ring Change out	Two Tools developed by HMB Subwork Ltd. — Internal Fitting External Fitting
Survey	All known survey systems can be used in conjunction with Mantis. Spare ways available in umbilical.
Sonar	Fit as required Usually Ametic Straza

The Arms Bells, MOB units and Checkmate are all characterised by being 4-5 times heavier than Mantis and utilising proven diving system technology for handling and deployment. Their very size reduces the capability of gaining access to the same types of areas as Jim/Wasp and Mantis. They do, however, appear to be rugged and familiar to many end-users and diving companies and it is probably this familiarity which has led to their development. They also have the capability of using more electrical power than Wasp or Mantis, allowing for high thrust configurations.

The biggest drawback associated with using Bell derived units is their weight which necessitates dedicated handling systems, large areas of deck space on rigs, and very heavy support equipment. The single Mantis operating spread or a Jim/Wasp spread weighs approximately 10 tonnes complete compared with around 30 tonnes for a Bell plus handling system, or 40-50 tonnes for a 1,000 saturation system at its lightest.

Safety

The safety of the systems with which we are associated is a major consideration at the design stage and our

approach to systems' safety has been vindicated in operations to-date. We have always maintained the closest relationships with the operators of these systems, and the feedback on safety has resulted in a number of detailed changes. It seems clear to us that there are long term pressures to remove man from the sea. These pressures are probably generated, initially, by Government and by public attitudes to safety. In this respect the oil companies reflect changing attitudes and at some stage may try to impose the use of remotely operated systems in the market.

The problem with safety is that removing man from the sea is only going part way to satisfying the problem of working offshore. The recent tragic accident off Norway shows how dangerous the environment is in any event, regardless of whether man is above or below water.

From a pilot's viewpoint these systems are thought to be very safe. There is certainly no lack of applicants to work in them. The confidence of the pilot depends on a number of psychological factors as well as physical. The redundancy built into life support systems and the methods for disentangling the submersibles are the major factors enhancing his confidence. The proximity of a rescue submersible is also a major confidence factor.

It is worthwhile considering the analogous situation when the aviation industry was very young. The number of accidents with respect to the number of aircraft was very high; however today almost everyone accepts the risk of flying as being minimal, even in rotary wing aircraft on chartered flights to rigs. There is no legislative pressure to curtail the use of aircraft and send people by surface transport in all cases; and indeed most Governments are dedicated to increasing the use of air transport, through their support of national airlines and aviation industries. Hopefully the use of manned submersible systems, and an ever improving safety record will lead to a similar situation in the offshore industry.

To return to the theme of overall safety offshore, it is possible to hypothesize a situation where, for example, a blow out has occurred. Perhaps an ROV has been used to observe, and try to rectify the problem which has obviously increased the overall danger to rig personnel by a very great extent. The only way left to constructively minimise the danger may be to use a manned submersible with its still superior dexterity and work capability compared with ROV's in general. In these circumstances it can be strongly argued that the use of a manned submersible system has reduced the danger to the whole rig, and all its personnel.

End-user attitudes

At this point it is probably relevant to discuss general attitudes of the operating oil company. Speaking as a manufacturer involved in what is a tremendously exciting and innovative field of technology it is easy to lose sight of the fact that rig support systems are solely an insurance policy for the drilling company.

In most cases the rig operator would prefer to have no diving system, and no submersible system of any sort on board. If the operator is persuaded to install a system, and if that system should in any way fail to save him the downtime caused, say, by having to lift the BOP stack then his investment in the insurance policy is void. In most cases the operator wants the cheapest form of insurance policy, but there are problems involved in this approach. It is too optimistic to place a contract for the use of this sort of support system only days before the rig is due to spud in on the next hole, and expect instant results. Although the lightweight systems take very little time to install, every rig differs slightly and the solution of mundane problems such as siting of power packs and winches, connection of electrical power supplies, etc., can sometimes be frustratingly delayed so that crews are not in a state of readiness when first called upon to perform in the operational condition.

Once the system is installed on a rig it is probably best to keep diving as often as possible to improve the pilot's expertise when real emergency situations arise. This is one of the fundamental attractions of tethered atmospheric systems and ROV's. There is no lengthy compression or decompression time associated with their use. There is rarely a financial penalty incurred by their use apart from minimal daily operating costs, so the best way for the customer to obtain optimum task performance is to repeatedly use the systems installed on his rig.

New developments

Most projections for offshore drilling rig utilisation suggest that wells will be drilled deeper and that 50% more holes will be drilled annually by 1985. A recent paper (Ref. 2) suggests that the practical limit for saturation diving is 1,000'. If oil companies wish to have some form of intervention system on board for greater depth it must be either an ROV or a submersible, probably tethered. At this time the maximum operating depth of the lightweight systems is 2,300' and the Bell systems approximately 3,000'. We are working on the development of a Mantis derived type of tethered submersible for deep water rig support in depths up to 5,000' and potentially 20,000'. It is hoped that the first units will be available for work in the early summer of 1982. These units will possess high manoeuvrability and ample dexterity through the use of a radically different type of manipulator. For the first time a 5,000' work capability weighing less than 3 tonnes will be available to the offshore industry.

We are still developing the operating concepts for using these systems in the drilling rig support mode but are confident that their performance will meet our rigorous specification. It is anticipated that a very light tethered cable relaying voice communications, video and sensor data will be utilised, giving the benefits of real time data at the surface, combined with a lightweight handling system requiring far less deck space than the conventional diving bell derived units.

The development of our new manipulator represents a major improvement in dexterity by using a completely fresh approach to the problem. Naturally patent protection has been sought for this remarkable device which it is hoped to demonstrate shortly.

New applications for the lightweight systems are being developed at present. The use of sensors such as sub-bottom profilers and side scan sonars, coupled with acoustic navigation for such tasks as pipeline route surveys is being actively pursued. There is also an increasing amount of interest in a concept which we have put forward from the very first development of Mantis, that is the use of a remote control package. We have previously concentrated our efforts on ensuring that the basic systems are reliable and effective. We are now actively pursuing a

development programme whereby remote control options are made available in which the pilot can override remote control if he is in the vehicle, or the vehicle can be used without a pilot for the same range of tasks as the manned vehicle. We do not anticipate attaining the same performance but there are certain circumstances where the dual capability, particularly for hazardous inspections, could be very useful.

It is hoped that this paper has shown that tethered submersibles have achieved the task performance required of them, that their use is increasing rapidly and will continue to do so for at least another three years. The development of new types of vehicle retaining the merits of the A.D.S. concept at great depths has been indicated as well as the acceptance by the industry of the present systems as a standard approach to support work.

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Comex Launches New Lock-Out Submersible

France's Comex Industries has launched a new lock-out submersible, the SM 360, that can conduct observation missions to a depth of 300 m. for site inspection, determining geographic locations, monitoring drilling operations and guiding re-entry.

The SM 360 can carry three workers and conduct atmospheric transfer operations on seabed production facilities. Divers operating from the SM 360 can carry out many of the tasks executed from a diving bell (one main advantage is that the lock-out sub can gain access to some subsea structures where a conventional diving bell cannot intervene). Comex will be seeking various types of contracts for the SM 360 including maintenance and control of subsea production facilities, pipeline surveys, clearing loads, cutting and releasing cables and fishing net, inspection of connections and rings of subsea equipment and control of trench profile to check the burial of pipe.

MAJOR SUBSEA MARKETING AGREEMENT

Comex Houlder Diving Ltd. are to expand their manned and unmanned submersible operations, with the announcement that the company will have worldwide marketing rights for HMB Subwork's *"Mantis"* submersibles . . . and with the purchase of three *"Scorpio"* vehicles from Bennico (UK agents for Ametek Straza), and the addition of a third RCV—225 (the 50th produced by Hydro Products).

Gt. Yarmouth based HMB Subwork own five *"Mantis"* submersibles, and are the largest operators of the British-built OSEL *"Mantis"*. Under the recent agreement Comex will market the *"Mantis"* range, while HMB Subwork will provide operational expertise.

The first *"Scorpio"* is expected to be operational early in 1982, and the latest 225 is to be supplied in a special "gold" finish.

Comex currently operate RCV-225's for Shell and Total.

Subsea

British Oceanics Ltd has completed an extensive integration and reorganisation programme following the acquisition of five submersible support ships and 11 submersibles previously owned by Intersub. With the integration of two fleets, BOL is now able to offer a sophisticated data gathering service operating from either conventional or advanced dp support vessels for up to 20hr subsea operations using a manned submersible, a support vessel operating one or two diver lock-out submersibles, or a combination spread with a manned and an unmanned submersible for sophisticated inspection services deploying ROVs on round-the-clock operations supported by a manned submersible for specialised tasks.

Wharton Williams Taylor has purchased the remotely controlled submersible, *Scorpio II*, bringing up its number of deployable ROVs to ten (two being their own RCV-225s and seven of the same class were acquired following the agreement with Taylor Diving & Salvage Ltd, resulting in the Wharton Williams Taylor joint venture).

The submersible can be deployed for rig intervention and a wide range of inspection, monitoring and manipulative duties and will feature full pipe logging, including trench profiler, pipe tracker, current density equipment, colour stills camera unit, colour video, character generator, cable cutter, acoustic altimeter, uprated hydraulic power from 15hp to 25hp, extra lighting and a spare multiplex channel capability.

Comex Industries has designed a simulator for training operators for its range of observation lock-out submersibles. The system can simulate check list before launching, tests after launching, descent and navigation, recovery, underwater survey, lock-out operations, tasks with manipulative arm, and emergency situations.

The simulator has three major components: the crew's compartment, which recreates the interior of a submersible, including all atmospheric electronic, electrical, gas and pilot controls and a video projector, facing the viewports, which displays a simulation of the outside environment obtained by moving a colour video camera along a landscape which can be changed for various situations. The third component, the instructor's console and computer, comprises a series of screens which display all information regarding the propellors, thrusters, trim, speed, sonars, navigation and electronic equipment, as well as the trainees' reactions. Different computer programs are available for the various levels of training, the model of the submersible and the type of operations to be performed.

Depth Record Established In Atmospheric Diving Suit

Oceaneering International's WASP Atmospheric Diving Suit (ADS) established a new depth record on January 21, 1981 when it reached 543 MSW in the Gulf of Mexico. The Oceaneering ADS operator was Steve Etchemendy.

The WASP is a one-person, thruster-controlled submersible rated for operation down to a depth of 610 meters. The suit provides the operator with a one-atmsphere (surface pressure) working environment.

Titanium Hulls Predicted On All Ships By Year 2000

The president of an integrated producer of titanium mill products predicts by the turn of the century virtually every ocean-going vessel could have a titanium hull. James L. Daniell, president, RMI Co., Niles, Ohio, said, "with its high strength-to-weight ratio and resistance to corrosive environments, titanium is an ideal material for the construction of a ship's hull." Ships built with a titanium hull would be considerably lighter in weight and, thus, be able to attain higher traveling speeds while carrying heavier cargos. And, equally important, the ships' hulls would not have to be re-painted every six months or so as they are now."

He added that the savings in painting, maintenance and repair would, in the end, offset the higher initial costs of titanium, pointing to the Soviet Union's experience with its new fleet of titanium submarines as an example of what the use of titanium can mean for ocean-going vessels.

Daniell said, "We understand the Soviet Union has built nine titanium submarines that can travel as fast as 40-plus knots underwater and can dive as deep as 8,000-plus feet—far beyond the capabilities of our present fleet of submarines. This country's experience with sea-going vessels made from titanium is limited to a select number of hydro-foil ships and research submersibles like the *Alvin* and *Sea Cliff*."

The *Alvin*, refitted two years ago with a titanium pressure sphere, can now dive to 3,657 m. The *Sea Cliff*, presently undergoing a conversion to titanium, will have a 6,096 m diving capability.

Observation Manipulator Bells Move Into Subsea Construction

With their success in the construction of the world's deepest undersea pipeline, the 154 km Trans-Mediterranean line which extends between Tunisia and Italy, observation manipulator bells (MOBs) are now gaining ground in new markets which could double demand for the product, observes Perry Oceanographics, a Riviera Beach, Fla.-based manufacturer of the systems.

Until now, the use of MOBs has been confined for the most part to support of exploratory drilling. The Perry MOBs used on the Tunisia project were battery-powered, tethered vehicles, which provided a one-atmosphere environment for 2 crew members. Capable of operating in 914 m depths, the vehicles are equipped with two manipulator arms able to perform a variety of tasks from cutting to undersea component assembly. The Mediterranean project involved the placement of jacks which support the pipeline as it spans subsea gullys. As the pipeline was laid, the OMBs also positioned all saddles, weight clamps and mats to further stabilize and anchor the structure.

The Diving Market

After several years in a slump, the diving industry in support of offshore oil and gas operations is experiencing a prosperous cycle. Currently there is an increase in the number of divers employed in oil and gas projects worldwide and an increase in the terms and number of diving contracts. The diving field, dominated by less than a dozen companies, is presently a fiercely competitive market with costs reflected by both the inherent risk to human life in traditional diving systems and the difficulty of the task to be performed.

Diving operations in the offshore oil sector generally includes diving in support of exploratory and construction activities as well as maintenance, inspection and repair of production platforms and subsea pipelines. Most diving contractors agree the demand for maintenance/inspection and repair services is stronger now than the market for diving services aboard mobile rigs (semis and drillships.) But this situation will change when the new round of semisubmersible orders starts coming out of the shipyards next year and enters the fleet.

For the past several years, there has been a surplus of diving equipment, including diving bells and bounce and saturation diving gear. But now the supply of equipment is coming more in balance with demand. While diving activity is increasing on an across-the-board basis, contractors say the upsurge is not yet altering price structures. This probably will not happen until the oversupply of diving equipment is fully absorbed.

Diving activity is the strongest in the U.S. Gulf of Mexico, Southeast Asia and offshore Mexico. Contractors are hopeful that the market off Brazil and West Africa will pick up shortly. Divers are also eyeing Chinese waters for future contracts. Maintenance and inspection is expected to boom in the North Sea area as more fields reach the development stage.

Internationally, the trend for major rehabilitation and extension of service life of aging production facilities has been strongly fueled by rising crude prices. Demand for maintenance and inspection also will flourish because many government authorities are demanding routine inspections of facilities to avoid major catastrophies. Stronger demand also is expected for construction diving in the North Sea and other regions in 1981-1983.

A number of emerging trends in the diving market are gradually changing the roles of subsea support companies. There is greater acceptance of the diver alternative methods—remote-controlled vehicles, one-atmosphere diving equipment and the arms bell. Some of these diver alternative systems can extend down to the 3,962 m level whereas simulated wet dives have only extended to the 686 m mark to date. The range for the one-atmosphere diving systems is presently 610 m and remote-controlled vehicles are rated for 914 m but can work at much deeper depths with alterations in design.

Another trend is the current development of newer types of manned and unmanned diving systems to replace divers in deepwater areas.□

CRY X-RAY

or the Incomplete Guide to Subsea Flying

By J. M. Gooder

IN response to those intrepid scuba divers of Stoney Cove who recently viewed a strange looking yellow monstrosity dangling from a JCB arm and, in reply to the numerous passers-by who questioned the equally strange gaggle of assorted humanoid forms gathered around any available heat source' . . . the machine was a Wasp.

The heavily clad and shivering group of individuals were professional divers plucked from the four (and mostly warmer) corners of the world and placed in Stoney Cove in order to learn the art of piloting Wasp. Those with the better tans and larger goose-pimples were from Singapore and South East Asia. The individuals with a poor grasp of the English language, chewing tobacco and suffering hamburger withdrawal symptoms were American and the remainder (suffering equally) were British.

THE MACHINE

Wasp is a second generation Atmospheric Diving System (ADS) following on from the success of the seabed working Jim suit. With Wasp's midwater capability, a combined Jim/Wasp operation can competently handle the majority of oilfield subsea, inspection, maintenance and construction tasks from a depth of 2,000ft to the surface.

Wasp is provided with the latest series of multi-jointed 'arms' and manipulators but, in order to 'fly' midwater, the Jim legs have been abandoned in favour of an array of six vertical and horizontal thrusters allowing a high degree of manoeuvrability and power enough to be able to hold station in currents of up to 1.25 knots.

With the addition of thrusters, there is less reliance on the muscle power required to move Jim around the job site, but working midwater brings in an additional dimension which initially does nothing to diminish the frustration of the trainee pilot. Despite the apparent ease with which a skilled operator can manoeuvre Wasp in all planes, there is, in fact, a complex and well choreographed 'tap dance' being enacted within the confines of the cabin. Because the arms must remain free to handle the manipulators, all thruster movements are controlled by means of four footswitches. Forward and reverse are simple single switch operations of the right foot but, by selecting one of the two 'mode' switches under the left foot and combining it with the right foot switches, the forward and backward control becomes the up and down or port and starboard spin controls.

It is, to say the least, quite an unnerving experience to find yourself on rapid collision course with an underwater rock face when you thought you had engaged the up 'gear' and the position of reverse does not readily spring to mind. That is, of course, where the majority of the problem lies, the trainee pilot has to consciously think about the directional controls prior to implementing any action. The fully fledged operator works solely on reflexes. Like driving a car or playing the piano, the conscious mind plays a very minor role. Thankfully this blissful state can be attained in a surprisingly short period. Necessity being the mother of invention and with the last batch of trainees possessing a particularly highly developed sense of self preservation, within 1½ hours dive time all members of the group were flying like veterans.

ACTION & REACTION

Surprisingly one of the most difficult manoeuvres (and the most useful) is just remaining stationary. The opposing forces arising from weight, buoyancy, current, momentum etc., must be exactly countered by small bursts of thrust. This hovering (or 'hoovering' as the Americans would insist on calling it — just to add confusion) is very necessary when using the manipulators for the more delicate midwater tasks. There is nothing more frustrating than picking up a tool (remember that changes your buoyancy) positioning it in the manipulator and then finding you've drifted and sunk 20ft from where you want to apply it. The pilot also soon becomes very aware of the third law of thermodynamics. As with astronauts, the action and reaction syndrome can, if ignored, place you on some very strange and embarassing trajectories, when all you wanted to do was tighten up a nut.

All this explains the fact that, despite the freedom of approximately 120ft of water offered by Stoney Cove, most of the Wasp training time is spent a mere 20ft below the surface, on a suspended workbench connecting and disconnecting hoses and shackles and tightening and loosening various sizes of nuts and bolts. These tasks are not made any easier by the close proximity of high speed water skiers being dragged around by 'V8's' mounted on surfboards, and having to extract inquisitive scuba divers from the thrusters as you fight for elbow room . . . but it does make life more interesting. As a reassuring 'last word' of instruction prior to entering the sub we were told, "If you get into real trouble, repeat the word X-ray". This is apparently the universal submersible pilot's cry for help. Very roughly translated it means, "Please cease drinking coffee etc, I'm getting rather wet down here/the cabin's on fire and I wish to abort the dive at the earliest convenient moment . . . preferably yesterday."

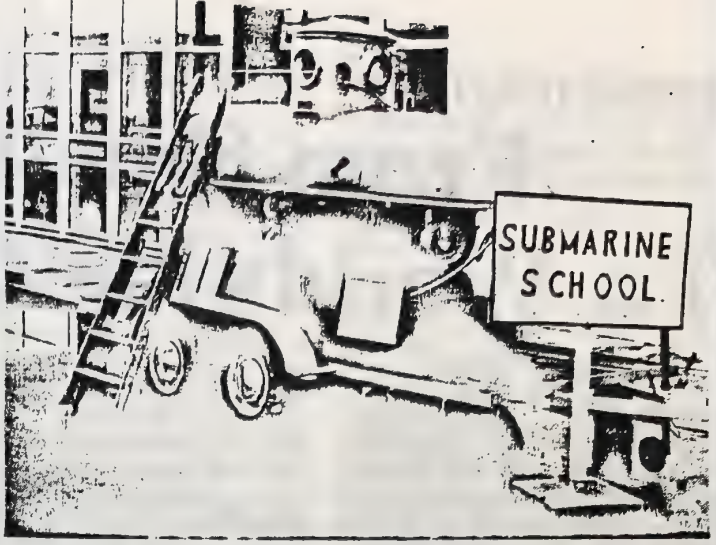
CABLE STITCH

Apart from the fact that conventional commercial diving cannot as yet extend to 2,000ft, Wasp (as with any ADS) has the advantage of not requiring lengthy diver decompression, elaborate surface support or large volumes of expensive diving gases. An ADS operation requires only a five man team of operator/technicians with relatively little deck space for power pack, winch and control console. Wasp does not of course have the same manual dexterity as a wet diver but, by adapting standard tools, there are very few tasks that Wasp cannot complete.

Wasp has proven its worth in long standing contracts worldwide. So I suppose it's not really surprising that these machines could withstand the punishment given out by a bunch of 'green' pilots attempting to hurl themselves at every conceivable submerged inanimate object and knit some form of complex cable stitch with the power umbilical. For my money, if they can withstand that, the North Sea presents no problem.

FOR SUBMERSIBLE VEHICLES

Pressure compensated DigiCOURSE compasses are designed for installation outside the hulls of submersible vehicles. With resolutions of .35° or 1.0°, they transmit accurate directional information to the interior of the sub and to the surface for visual digital monitoring and further electronic processing. Ask about Models 312 and 310.



DIVE A YELLOW SUBMARINE

LOCATED in the inner harbour of Brighton Marina is the Submarine School — apparently the only place in the world that offers training in basic submarine pilotage. I was invited on a one day course by Jo Davis, co-owner of the school.

It all started at 09.00 with a two-hour briefing on pressure laws, physiology, how to operate the submersible and, most important of all, the life support system. After the theory lesson we moved from the caravan/lecture room to the dry sub — one of two Ketteridge K350s owned by the school. All the strange terms and techniques began to fit into place now that I was sitting inside the sub on dry land!

We went through a full pre dive check, as we would before our dive that afternoon. It was very reassuring to see the K350 was fitted with full life support for 72 hours, including oxygen and air cylinders, carbon dioxide absorbant, through water communications, auxiliary lighting and a complete aqualung . . . just in case.

In the afternoon we met at the submarine jetty in the nursey area for our practical tuition. The second sub was moored alongside a jetty, rubbing shoulders with expensive yachts and looking somewhat out of place. Once again, a full pre dive check was carried out on the thrusters, breakers, drop weights, gyro, sodasorb, etc. The submariners have a language of their own.

Feeling apprehensive, I secured the hatch on the conning tower and all systems were operative. I was given permission to dive and, with the thrusters in reverse, the K350 slowly moved into a quiet channel with 15ft of water below. I flooded both main ballast tanks, fore and aft, then the variable ballast tank, for a controlled descent to the bottom. Once there, I checked with the surface supervisor and gave him a full bottom report. The carbon dioxide was building up, so I injected more oxygen before moving on to roam about, tethered in the confines of Brighton Marina's inner harbour.

It was quite an experience, travelling at 3 knots and watching the concrete bottom through viewports. I ran on a course of 160° before hitting a concrete wall, "Ouch!". Time to ascend. Variable ballast tank blown . . . on surface . . . main ballast tanks blown. Careful manoeuvering of the thrusters and I was back in the dock, feeling very pleased with my first submarine dive.

The cost of the one day course is £39 — quite reasonable when you consider that a new Kitteridge K350 costs £20,000. Two day courses are also available at £69.

Further details from : The Submarine School, c/o 4 Hapstead Cottages, Ardingly, West Sussex. Tel. 0444-892066.

Star II* Submersible Reincarnated as *Makali'i

During the early and mid-1960s there was a splurge of building small research submersibles. Among them was *Star II*, a two person vehicle. It was built by General Dynamics/Electric Boat and launched in 1966.

As with others, Electric Boat found little call for the small subs and eventually sold it. Its fate was better than some others, however, for it wound up collecting jewelry grade black coral near the Hawaiian Island of Molokai, operating from the Makai Pier at Makapuu Point, the eastern tip of the island of Oahu.

At first the operation was a financial success. Insurance costs eventually caused Maui Divers to abandon the venture. The University of Hawaii bought the vehicle.

After undergoing numerous alterations, it has now emerged as a reincarnation named the *Makali'i*. It was rededicated May 7 and is now embarked on research projects as the Hawaii Undersea Research Laboratory (HURL), a project sponsored by the National Oceanic and Atmospheric Administration (NOAA).

Operating with a transport-launch-recovery vessel, *Makali'i* is operating with scientists aboard, initially collecting sea plants near Molokai for study as to their usefulness in making pharmaceuticals.

Next month an expedition will go to Eniwetok Atoll, 2,400 miles southwest of Hawaii, to study continued effects of nuclear weapons testing. Studies below scuba diving depth never have been made there before. *Makali'i* can dive to 365 meters.

Profile: IUC, Inc.

From Small Shop To Worldwide Operations

by Michael Mulcahy
Managing Editor

City Island, N.Y.—The clapboard house seems more like a renovated setting from a Melville novel than the nerve center controlling activities of divers, submersibles and equipment around the world. International Underwater Contractors, Inc., (IUC) has come a long way since being established in 1962. In the two decades since then, the company has evolved from an operation of four or five divers to a true international economic force.

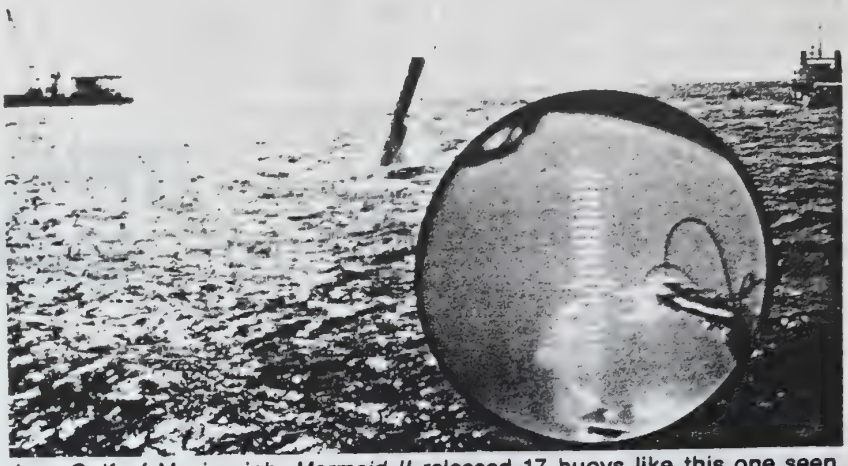
The IUC group of companies has several elements—spread from New York to Singapore, but for purposes of this profile only two major companies will be treated. They are International Underwater Contractors Inc., (IUC) City Island, N.Y., and IUC International Inc. headquartered in Hamilton, Bermuda, and chartered in Panama.

IUC Inc. contracts for both shallow and deep diving operations—including salvage—with open water divers; submersibles; remote controlled vehicles; much other hardware and a great deal of technology in the continental waters of the United States and for customers from other nations in various foreign waters.

IUC Inc. is also the United States representative for Deep Sea International, Inc. (DSI), a subsidiary of IUC International Inc. DSI owns the diver/submersible support vessel, *Aloha*; 305 m submersible *Mermaid II*; and several remote controlled vehicles.

IUC International

IUC International was established in the early 1970s to provide deep diving support of overseas oil exploration and production. Some 110 divers are assigned to the company, distributed about evenly among Singapore; the Mediterranean; Africa; and the North Sea. The company has one 366 m saturation dive system; three 305 m saturation systems; five 183 m bounce dive systems; and eight ambient diving bells.



In a Gulf of Mexico job, *Mermaid II* released 17 buoys like this one seen breaking the surface. Buoys were at 98 m depth, 10 m x 90 cm.

A major investment made by IUC in the last five years is the modification of the research vessel *Aloha* for support of diving operations and deployment of the 305 m submersible *Mermaid II*. The ship itself is 165 gross tons. Her length is 44 m, beam, 10 m; and loaded draft, 2.5 m. She can accommodate 22 persons, and has a range of 6,000 nm. In addition to habitability items that influence crew morale, she boasts a complete machine shop enabling fabrication of parts *in situ* when necessary.

Aloha is based in the Gulf of Mexico, and is available for pipeline or rig/platform inspection and survey; search and recovery; oceanographic, geophysical and bathymetric surveys; and installation or retrieval of sensor packages.

One recent job involved the release of subsurface buoys 100 miles off the Texas-Louisiana border last year. It involved 29 separate nylon hawser cuts, in waters from 67 to 98 msw. Several general inspection dives to appraise the condition of a 610 m, 30 cm pipe were made by the working submersible, *Mermaid II*, over the three-day period. In all, 17 buoys had to be released, in a carefully prescribed manner. IUC personnel, under the direction of the customer's engineer in charge, cut the hawsers in specified sequence so that the pipe would be positioned properly when it settled.

Because the tremendous upward force of the buoys which would be exerted in unpredictable directions upon the severing of the lines, their release had been deemed a highly dangerous job to be undertaken by divers. Each time their 3.2 cm hawser was severed by *Mermaid's* cutter, they rushed to the surface and breached—in some instances—completely out of the water.

Mermaid II

IUC decided to modify this submersible to suit the company's operating needs. It now has been almost completely altered from its original configuration, with only the ballast system unchanged. IUC installed a 76 cm bow window and made the stern thruster slewable, and also changed the propulsion system from hydraulic to electric. The German manufacturers, Bruker-Meerestechnik, now include

(Continued on page 24.)

comparable bow windows and slewable stern thrusters as standard features on their submersibles.

The *Mermaid II* can operate up to eight hours on a single battery charge depending on the mission. She requires a crew of one with room for 1 or 2 observers, cruises at 1.5 kts and has a top end of over 2.0 kts. Life support is 240 man hours. Her dual manipulator arms have six degrees of freedom and inspection equipment includes a pan and tilt color Closed Circuit Television (CCTV) and still 35 mm camera. Sonar is a Wesmar 140 and communications are via a Mesotech U/W acoustic 9 and 27 kHz set. Acoustical tracking is accomplished by a Honeywell RS-7 Acoustic Position and Tracking System. *Mermaid* is launched over the stern of *Aloha* in sea states up to 4, and can be recovered in up to sea state 5. Her payload is 454 kg.

In the winter of 1979 off Block Island, N.Y., *Mermaid* inspected a transatlantic cable. The sub covered up to five miles per day, while detecting and following the buried cable with a sophisticated detection system under conditions of strong current, in water depths of 200 m.

Mantis

IUC took delivery in January 1981 of the 700 m tethered, manned one atmospheric diving system, *Mantis*, manufactured by the OSEL Group, Great Yarmouth, U.K. This vehicle is extremely versatile and can operate from the *Aloha*.

A hydraulic crane has been installed on the *Aloha* capable of handling either RCV, diving bell, or *Mantis* on the deck or as a backup for the main lift system in launch and recovery. Many variables are involved, but good safety practice dictates no more than 6 hours for a normal work dive. *Mantis* is rated as the world's smallest submarine according to IUC, and more time than this in the confined space the vehicle affords would mean undue stress on the pilot (the writer crawled inside a *Mantis* displayed by the OSEL Group at the recent Association of Diving Contractors meeting in New Orleans). Under emergency conditions, however, should the tether be severed or jettisoned, the pilot has over 100 hours of life support and 40 hours of full thruster power. IUC said it especially likes the midwater capability of *Mantis*, compared to some ADS equipment which must be either on the bottom or on a platform in order to work.

The single tether cable to the surface supplies hardwire communications to the pilot, and video channels. The cable doubles as a lifting cable. As this was being written, IUC ordered a second *Mantis*, for delivery this month.

IUC Inc.

In New York the company is nestled into a 7.5 acre section of tiny (1.5 x 2 mi.) City Island, accessible from New York City by expressway and drawbridge. The island itself has a seafaring flavor dating from the days of Dutch colonization when it was one of the two major ports serving what is now New York City. In many ways the entire company's affairs are overseen from this frame house with a distant view of Long Island Sound. Company founder Andre Galerne is to be found here periodically, when not required elsewhere looking for new business. The day-to-day affairs of the company are administered by General Manager Thomas Conway.

The City Island complex involves several structures and associated activities. Adjacent to the headquarters building are a shop for submersible work (including modification of the *Beaver Mark IV*, scheduled to be completed soon); storage areas; and the Professional Diving School of New York (PDSNY).

When *Sea Technology* visited on a blustery January day the wind was wet and cold off the Sound. Spare parts, portions of diving bells and decompression chambers, small boats and skids for shipment of heavy equipment were seemingly everywhere—the sort of gear often seen whenever there is purposeful work in progress toward a deadline that is not far off.

Equipment available out of the City Island facility includes the following:

- Six 80 m dive systems, consisting of chamber and ambient bell.
- *Pisces VI* submersible.
- *Beaver Mark IV* diver lockout submersible.
- Four Deck Decompression Chambers (DDC)
- One 183 m bounce dive system.
- 10 shallow water (i.e., less than 30 m) dive packages.
- Floating assets including two workboats, one tugboat and two barges (one standard and one jackup).
- Services of as many as 60 divers.

The Deep Submergence Division is currently 35 people strong and plans are for it to expand to double that size by December. Division head is Chief Pilot, Booker T. Washington, veteran of eight years as a U.S. Navy diver and with IUC for the past fourteen years, first as a supervisor of diving and salvage and later as a submersible pilot leading to his present position.

The purview of the division extends to the activities of all undersea vehicles the company owns, both manned and unmanned. At present, eight submersible pilots assigned to *Pisces VI* are qualified to take it to maximum depth. A company requirement is that all submersible pilots also be qualified divers.

As of press time, the City Island complement of divers numbered approximately 90, including the eight *Pisces* pilots; divers for three exploratory rigs in Africa and for local inspection and salvage work.

Pisces VI

This "deepest" of the deep-diving *Pisces* class, as IUC refers to her, has a current operational depth of 2,012 m, with a design depth of 2,530 m. In 1979 the drill ship *Discoverer Seven Seas* set a new deep water drilling record of over 1,460 m offshore Newfoundland. At the moment *Pisces VI* was on the bottom setting a depth record for commercial manned submersibles and relaying engineering guidance and observations to the surface vessel. Now it routinely performs alignment and positioning tasks relating to installing a permanent guidebase and subsequent re-entry of casings, drill strings and blowout preventer stacks.

Pisces is outfitted with an external CCTV unit; external still 35 mm camera; six-function manipulator; and various systems for communication, navigation and positioning. The sub's payload is 680 kg, and it carries life suport for 250 man hours minimum.

As of press time the *Pisces* was still aboard the Offshore Company's *Discoverer Seven Seas* drillship. In the last two years she has completed more than 300 dives to depths of over 1371 m in support of the support vessel's deep water drilling contracts. Other tasks performed included changeout of the ship's sonar positioning beacons; complete riser inspections; directing re-entry of the drill string; and inspections of the blowout preventer (BOP).

First Fish Of Kind Taken By Scripps Scientists

By LINDA KOZUB
Staff Writer, The San Diego Union

Scientists from Scripps Institution of Oceanography, just returned from a successful geochemical treasure hunt in the Pacific Ocean, have accidentally captured a deepwater fish which apparently is the first of its kind ever to be collected.

"It was pure luck," announced biologist William Smithey yesterday during a press conference at Scripps. "You could say the fish were accidentally kidnapped."

Three white fish, about an inch wide and from eight to 10 inches long, were among the research riches gathered from a Scripps Institution expedition off Baja California.

The oceanographic vessel Melville returned Monday night.

The fish, now frozen for preservation, lived near a hydrothermal vent — a hot spot on the sea floor. The vent was located about four miles from previously known vent fields and at a depth of 8,500 feet.

This new vent site is located on a hill leading to a field of sea "chimneys" which spew hot hydrothermal water reaching temperatures of 660 degrees Fahrenheit.

The purpose of the geological and geochemical expedition was to collect fluid from this high temperature vent field, and three other such vents, said Dr. Harmon Craig, chief scientist aboard the Melville.

During two dives of the research submarine Alvin — which worked with the Melville during the expedition — the vent fish were accidentally trapped in the submarine, Craig said.

The fish apparently were in the hatch area of the three-man submersible and became trapped when it began its ascent.

"What makes the finding of these fish so exciting is that they've never been captured before. There's a whole host of deep sea animals around these vents but little is known about them. They've been observed before, but never captured," Smithey said.

Dr. Richard Rosenblatt, a marine biology professor, speculated yesterday that the deep-living fish may be in the *Aphyonidae* family. The genus may be *Meteoria*.

But Rosenblatt stressed that more study of the creature is needed before the animal can be named or categorized with certainty.

"The fish are obviously predators. They have sharp teeth and have probably eaten tiny organisms," Craig said. He added that in their natural habitat, the fish are not exposed to light, and their black eyes, like small dots, did not seem to react to sunlight at the time of the capture.

Meanwhile, Craig reported that the expedition resulted in some new discoveries for geochemistry.

Titanium bottles, specially developed for the expedition, collected for the first time what Craig called pure hydrothermal vent fluids, uncontaminated by seawater or minerals in the collecting equipment.

It was previously known that these fluids, which spew from the deep sea hydrothermal chimneys, contain methane, Craig said.

Harbor Branch Submersible Completes 1000th Dive

The Harbor Branch Foundation submersible, *Johnson-Sea-Link I*, made her 1000th dive in February while on a routine scientific mission in the Bahamas. The first dive made by the *Johnson-Sea-Link I* was during her christening ceremonies on January 12, 1971.

Occupants of the Johnson-Sea-Link for the 1000th dive were Chief Submersible Pilot, Tim Askew and Scientific Observer, Dr. Robert S. Jones. In the aft dive compartment were Dive Tender Christopher Chulamanis, and Scientific Observer Christopher Donohoe, all staff members of Harbor Branch Foundation.

Harbor Branch Foundation operates submersibles exclusively for scientific research. Their *Johnson-Sea-Link* submersibles have made many major contributions to the advancement of man's knowledge of the marine environment. Some of the projects undertaken include over two month's work on the wreck of the Civil War ironclad *Monitor*, which lies in 70 meters of water off the coast of North Carolina. Johnson-Sea-Link submersibles have also been used to conduct baseline studies in the deep reef structures of Florida's marine sanctuary at Pennekamp State Park, in the Georges Bank area off Cape Cod, Mass., and in the Gulf of Mexico at the Flower Garden marine sanctuary off Galveston, Texas. Through these submersible activities many new species of marine organisms have been discovered and documented.

In other Harbor Branch developments, on March 9 Penny Hall, a phycology research assistant, made a 20-minute lockout dive breathing a 10 percent heliox mixture. She dived from the *Johnson-Sea-Link I* lockout submersible. The dive was made in support of algae collection off St. Lucie Inlet, Fla. Ms. Hall thus became one of the very few women to have locked out of a submersible to such a depth while breathing heliox.

Don Freeman

TV-RADIO EDITOR
THE SAN DIEGO UNION

The French flag is tattered at the edges, frayed by the winds at sea. It is a flag that has flown aboard the Calypso, under the command of Capt. Jacques Cousteau, from Yucatan to British Honduras to the Pacific and the Mediterranean and by Atlantic waters up to the Antarctic, and it is with quiet pride that Joe Thompson holds the *tricolor* aloft.

For Joe Thompson, the flag is a memento of one of his 12 voyages on the Calypso as an underwater photographer and pilot of research subs and, always, the only American working with the French crew in pursuit of scientific knowledge and entertaining television.

Jacques Cousteau

In the offices of Seavision Productions, which is a San Diego-based company under Thompson's wing, the walls are graced with a number of autographed pictures. One of them displays the lean, Gallic, ascetically intellectual features of this wizard of the deep waters named Jacques Cousteau, skipper of the wandering Calypso.

The inscription to Thompson reads: "Our good friend and Calypso cameraman, our smiling and efficient companion of already many years. From all his *amis francais*."

Capt. Cousteau is a fellow who gets around and he popped into town a few days ago in one of his rare visits to these parts. Most of his time here he spent with the tuna people. They filmed a sequence for Cousteau's final PBS special — Thompson was the photographer — as Cousteau inquired into the means by which the porpoises are trained, in essence, to escape the commercial fishermen's net.

"Cousteau," says Thompson, "interviewed Harold Medina, the skipper who developed the technique of saving the porpoises, and we went to the headquarters of the American Tunaboat Association and we had some kind of port liqueur. Cousteau drank the liqueur and he said, 'This is *beaucoup* marvelous!' They got along fabulously, the Frenchman and the tuna fishermen. Well, they do have a common bond — the sea."

THE NEXT DAY, Thompson accompanied Cousteau first to the Los Angeles County Natural History Museum and then to the hills of Orange County, 10 miles inland, for more filming — this time for Cousteau's new series for the Canadian Broadcasting Corp. It must have been pretty unusual footage.

"I'm holding the camera," says Thompson, "and these other people are doing the digging — and they're coming up with fossil remains and fossils of whales, rhino, camels, and it all has something to do with the sea and the Ice Age, and it's going to be very interesting television."

Jacques Cousteau is quite a piece of work and Joe Thompson, who first went aboard the Calypso in 1964, still holds the Frenchman in awe. But a subtle change has occurred with the years.

Joe Thompson has gone on to win Emmy awards, notably for his photography on "The Gossamer Albatross — Flight of the Imagination," which is about the fragile aircraft which crossed the English Channel powered only by the churning legs of the pilot. And just recently Thompson filmed another Channel flight, this one by a solar-powered aircraft.

"This time — for the first time — I called him 'Jyc,'" Thompson says, referring to Cousteau's nickname.

Pronounced to rhyme with squeak, "Jyc" stems from the initials of his name: Jacques Yves Cousteau.

"By now," Joe Thompson says, "I figured I was entitled. I've come up in the world. I'm no longer the young, eager engineer from Pennsylvania who reported to the stern captain of the Calypso."

"What did you used to call Cousteau?" I said.

"Commandant," said Thompson. "Cousteau is a retired captain in the French Navy but everybody on board would call him 'Commandant.' When he'd call, I'd say, 'Oui, Commandant!' That's most of the French I knew at first. His scientific associates would call him 'Jyc.'"

What sort of a fellow is he, this boulevardier with the trim frame of a matador and more than a *soupcon* of Gallic charm? "He's every inch the officer, Jacques Cousteau is," says Thompson. "He's a bit of an actor. He speaks beautiful English but only when he wants to. He adds a French flair to whatever he does. He's a tough taskmaster but he has good humor. He expects the best from everyone and he never gets less. He's a good guy."

JOE REMEMBERS WELL his first meeting with Cousteau, 17 years ago, at a sea museum in Monaco. "Cousteau's father was with him, in his 80s then, a marvelous, witty, delightful man who'd been a salesman of marine equipment. Cousteau *pere* had sharp eyes and sharp features, that Cousteau look, and you could tell the affection they had, father and son."

Jacques Cousteau has been the target of criticism by scientists who decry his show business leanings. We turned to that.

"Cousteau gets his barbs," Thompson says, "but there's a lot of envy involved. Dr. John Q. Egghead figures he should be on the television screen instead of the theatrical Frenchman. They resent him for being so theatrical. Well, he is. But he knows how to tell a story and how not to be dull. Cousteau never said that he's a big scientist himself but he always tries to have a scientist on every show. What Jacques does is bring the underwater world to the people who watch television.

"And nobody," says the man who now calls him "Jyc," with the respect of an old colleague at sea, "has ever done it better."

Mediterranean Pipeline Survey

Precision requirements in an offshore project sometimes dictates assembling a set of positioning equipment suited for the job. Such a situation occurred recently when Subsea Oil Services was preparing to bid on a pipeline survey project on the Trans-Mediterranean Pipeline. This approach ultimately was to be used in both the Sicilian Channel and the Strait of Messina.

Three basic objectives of the project were met by Oceonics Ltd., a British company that not only matches customer needs to equipment but furnishes technical assistance.

The positioning system needed to be built around an integrated real-time navigation package for the support vessel, the submersible, and the mobile observation bell. It would have to locate and measure pipeline spans and chart results on board ship.

Package Elements

The components of the package were defined as follows:

- Integrated ship's navigation system with multiple interface capability to various radio and acoustic navigation systems.
- Tracking system for submersible and observation bell.
- Long baseline acoustic navigation system for fitting to support vessel, submersible and bell for navigation within a transponder array.
- Acoustic array calibration.
- Submersible-installed system for interfacing Marconi Mini-Sonar, precision echosounder and depth sensor, heading gyro and long baseline acoustics.
- Pilot's display providing sub's position, left/right indicator, course to steer and distance to target.
- On-line data logging.

In addition, the on-board post-plotting system would have the following capabilities:

- Automatic analysis and processing of submersible produced tapes to give bottom profile, pipeline position and span location.
- Track plotting of submersible position from either long-baseline acoustics or surface navigation.
- Longitudinal profile of pipeline showing both pipeline and seabed.
- Data logging onto floppy disc.
- Data logging onto 9 track tape recorder.

Observation Bell

The simplest part of the project was the system for tracking the observation bell (manufactured by Subsea Systems itself) via either the RS-7 or Oceonlink system. Self-navigation from within the bell was achieved through the use of an HP 9825 computer, controlling information received from the Oceonlink system and presenting the pilot with positional information and course and distance to target.

Support Vessel

The vessel used was the *Subsea Buccaneer*, over 40 m long and fitted with handling systems for launch and retrieval of both the observation bell and the submersible. SCOPE 45 was used to harness navigational data from the various input sources. Information was received continuously from the gyro and RS-7, with selectable range inputs from the Syledis, Tellurometer and Trisponder systems. These data were fed to the ship's desk-top 9845 computer.

A sub-system using an HP9825 computer was provided for calibration of the transponders used in an Oceonlink acoustic system, which fed positional information on the bell and submersible directly into the 9845. This subsystem arrangement allowed the separation of the surface and subsea navigation systems without tying up the main computer. It also provided two fail-safe facilities. Firstly as an alternative method of tracking the submersible in the event of a malfunction in the RS-7, or if the sub moved out of range. Second, as an alternative navigation system in the event of failure of a primary radio system.

Thus, the support vessel had primary and backup navigation facilites; capability to log data in real-time mode and to output either onto the computer's built in printer or onto a 9872 plotter, and array calibration facilities. It could also determine and monitor the position of the bell and the submersible, through either the RS-7 or the Oceonlink system.

Submersible

The manned submersible *Leo* would be used to locate the pipeline, working with pilot and two observers to depths of 610 m. Sub time would be alternated with observation bell time in the water, with only one of the two operating at a given time. The navigation system for *Leo* was controlled by an HP 9825 computer with an I/O expander providing an additional six interface slots to the existing three. Position information was provided by an on-board Oceonlink system while course-to-steer and left/right course correction was calculated from information received from a Robertson heading Gyro.

The sub's Marconi "Hydrosearch" Mini Sonar, which provided a continuous scan of the seabed, was fitted with a strobe digitizer to enable the data to be recorded by the computer, and to determine the pipeline depth relative to the submersible's depth. A Marine Acoustics precision echo sounder gave additional depth information. These two systems provided the computer with rapid updates.

The 9825 also received information from a real-time clock, and a video date-time generator was linked to the video recorder. Data were output onto an HP 9875 cassette unit.

Software Development

Once a working hardware configuration had been agreed upon, two primary software programs were developed.

CANS (computer acoustics navigation and survey system) was the controlling program for the submersible equipment. It collated information from the Mini-Sonar, echo sounder, depth sensor, heading gyro and long-base line acoustics. It provided on-line navigation information and enabled additional sensors such as potential measurement, current density and pipe tracking.

SPANS (Seabed and Pipline Analysis System) was developed to allow the production of charts on board within a few hours of the data being collected. Pipeline engineers could then assess accurate positioning and determine whether any recorded spans were outside specified tolerances.

Photos Show Titanic's Propeller

ABILENE,. Texas (UPI) — Studies of underwater photos taken in the latest search for the Titanic show the ill-fated ship's propeller and may prompt a third attempt to board the vessel next year, according to expedition leader Jack Grimm.

Grimm, whose crew admitted at the end of this summer's expedition that they had not found an intact ship, said careful studies of the color photographs taken on the floor of the North Atlantic "definitely show a propeller of the Titanic."

Grimm said the propeller, about 16 feet in diameter, is still attached to wreckage of the White Star liner that struck an iceberg and sank April 14, 1912, killing more than 1,500 people.

"I'm certain we located the Titanic," he said on Tuesday. "The propeller blades are suspended well above the ocean floor and that means to me and my associates that the propeller is still attached to the shaft. The blades are definitely not rusting on the ocean bottom and it's obvious they have to be suspended from something."

Grimm said he and his associates were encouraged enough by the photographs to consider another venture next summer in the hope of entering the wreckage and searching for the fortune in gold and jewels said to have been stored in the purser's safe.

"I'm more confident now than ever that we can accomplish our objective now that we have located the ship," said Grimm, an oil millionaire who funded the expedition that tried to locate the ship the last two summers.

He said his next expedition may utilize the Alumінaut, a deep-sea submersible that carries a crew of two and already has been tested successfully at ocean depths of 15,000 feet.

The color photos, taken at a depth of more than 12,000 feet with exotic new deep-sea photo equipment, have been studied since the second phase of Grimm's two-year expedition concluded in July.

"Two blades (of the propeller) in particular are visible," he said.

The pictures were taken at 15-second intervals for several days in the course of dragging operations over the area where the ship went down, about 90 miles off the coast of Newfoundland.

WRECKS INTACT

Michael Jeffries writes: The city of Hamilton, Canada, is planning to raise two historic United States wrecks intact from Lake Ontario.

The ships are *USS Hamilton* and *USS Scourge*, which sank in 88m of water, 11-12km off Port Dalhousie, during a tornado in 1813. Both began life as merchantmen, but were converted into war-schooners in 1812.

They were discovered last year by Canadian diver Dr Daniel Nelson, who was exploring the lake in a submersible owned by the Cousteau Society.

The city of Hamilton received the title deeds for the ships after extensive negotiations with the US government. It is now trying to raise over seven million Canadian dollars to pay for salvage and preservation.

Nelson, who had spent 10 years looking for the vessels, said that in terms of preservation they could not have sunk in a better place. The water in that part of the lake is fresh, relatively still, and of constant temperature. The wrecks also lie deep enough to be fairly safe from treasure hunters.

After inspecting the hull of the *Hamilton* Nelson reported that she had only a thin coat of seaweed to show for her 167 years underwater.

Among early finds on the site is a carved figurehead of the goddess Diana, whose name the *Hamilton* bore before she went into military service.

Salvaging the ships is expected to take three years. In the meantime, they remain under police protection.

))) MacInnis Team Uses Benthos Vehicle to Photograph *HMS Breadalbane* in Arctic. Working from a Canadian Coast Guard icebreaker September 2-8, a team led by Arctic underwater explorer Dr. Joseph MacInnis deployed a Benthos, Inc., remotely-piloted vehicle called the RPV to take color video and still photos of the three-masted British barque *HMS Breadalbane*, holed by shifting Arctic ice and sunk in 1853. On August 13, 1980, following several years of research, MacInnis located the wreck, which has remained remarkably unaffected by exposure to water for 128 years. Two of the ship's masts are still standing. The 38.1 m ship is resting upright on its keel, as shown by the videotape. Water temperature was 1.5° below freezing, as the expedition's members "flew" the Benthos vehicle to the wreck site, at the depth of 100 m. Visible through a large hole in the ship's side were what appeared to be a tool cabinet, compass, navigation instruments and the ship's wheel. MacInnis, to whom diving beneath the Arctic ice is nothing new (he once escorted Britain's Prince Charles in a dive under the ice) praised the RPV since it made it possible to accomplish in four to six hours of time spent comfortably ensconced in the ship, what otherwise would have required a series of 30-minute dives with four hours of decompression each. Using techniques developed by National Geographic photographer Emory Kristof, the RPV was outfitted with six cameras, including black and white and color low light level TV. In a press conference September 14 at the Washington, D.C., headquarters of one of the mission's cosponsors, the National Geographic Society, MacInnis sounded a note of concern over the wreck's continued welfare, since a future seaway of the north, for transport of oil from the coast of Alaska and the Beaufort Sea, will pass directly over the wreck, which is located one mile south of Beechey Island in the Arctic.....In other ship diving news, divers of the National Underwater Marine Agency, Arlington, Va., have found the remains of two Civil War vessels off Newport News, Va. One is the *Cumberland*, a wooden Union frigate, and the other the *Florida*, a Confederate raider. They are within a few hundred meters of each other in the James River in about 21 m of water. The *Cumberland* was sunk in March, 1862. The *Florida* was scuttled in Newport News in 1864.□

High-Seas Piracy Is Back

Modern Buccaneers Plunder With Speed, Firepower

Cox News Service

WASHINGTON — The S.S. Santa Isabel was just easing out of a harbor on the western coast of Colombia at 6 p.m. last Feb. 11 when it was beset by one of the growing hazards of modern sea travel: gun-toting buccaneers.

As the Delta Lines ship steamed away from the port of Buenaventura, a stowaway suddenly popped out of his hiding place and pulled out a gun in an effort to rob the crew and passengers. There was a skirmish. One crewman was shot in the arm. But the thief lost his cool and leaped overboard.

The next thing the crew knew, a high-speed launch swooped up behind the Santa Isabel and picked up the stowaway. The captain radioed to shore for assistance. But, as a diplomat recounted the incident, "Port authorities report that they were unable to locate the launch."

That's the way it goes these days on certain stretches of the high seas. Off parts of Asia, West Africa and South America, modern-day buccaneers are increasingly plying coastal waters like the Barbary pirates of the 1800s and the Phoenician marauders who used to terrorize the Eastern Mediterranean in 2000 BC.

The passengers on the Santa Isabel were luckier than some. Exactly one year earlier, the British ship Icelu was boarded by pirates as it waited in the Pacific Ocean to enter the same Colombian port.

Attacking in five motorboats, the pirates, carrying automatic weapons, overcame the 20 crewmembers and made off with $100,000 worth of what a diplomat called "sophisticated navigational equipment and other supplies." The boatswain of the Icelu was seriously wounded before the pirates escaped.

Piracy has never been completely stamped out throughout the world. But in the last five years the Jolly Roger phenomenon has soared, to the alarm of oil companies, insurance agents, outmanned coastal police, and even harried drug smugglers who work Caribbean waters.

Six weeks ago, the U.S. Maritime Administration broadcast a warning to all U.S. flag steamship operators to "use caution" when passing through the Strait of Malacca between Singapore and Indonesia "because of several recent attacks on vessels by pirates."

The American warning said: "Singapore marine police have reported that the pirates used fast motorboats to pull alongside vessels transiting the Phillips Channel and then used grappling hooks to board the vessels. The crews were held up at knifepoint or gunpoint and robbed of money and valuables. . . ."

Exxon, Shell, Mobil and British Petroleum have all acknowledged that their tankers have been hit by pirate attacks in the Strait of Malacca within the last year. Among the targets have been the 90,000-ton Shell tanker Mammoth Monarch and the 26,960-ton Mobil ship Corsicana.

The Phillips Channel, through which more than 15,000 ships pass each year, is an extension of the Malacca Strait through which oil ships are virtually forced to pass on their route between the oil-exporting Persian Gulf and Japan. The Phillips Channel is five miles long and less than one mile wide at its narrowest point.

Shipowners represented by the General Council of British Shippers in Singapore, who have in turn appealed to Interpol. The Phillips Channel, however, is under the jurisdiction of Indonesia, whose island of Sumatra is thought to be the main haven for the buccaneers.

Perhaps the most dangerous waters in the last two years have been those in and around the West African ports of Lagos, Nigeria, and Freetown, Sierra Leone.

The International Maritime Bureau, a shipping group, recommended to all shipowners earlier this year that they remain 20-25 miles outside the two ports because of the danger of piracy. The bureau's report said ships anchored six miles outside Lagos have been attacked, and that in Freetown marauders "are commonly seen lurking in the harbor."

"Even if the boatmen choose not to board the ships themselves, accomplices on board throw packages to them which they then retrieve and make off with impunity at high speed," the maritime bureau reported.

The report cited instances in which ships have independently hired local tribesmen armed with bows and arrows, adding: "These are not proper guards but ships employing them have not been attacked."

The threat in Freetown, according to the report, is robbers using dugout canoes equipped with high-powered outboard motors. The dugouts are said to lurk under the bows of container ships, waiting for an opportunity to slip on board. Insurance investigators recommended that ship owners insert thick sheets of plywood between the container doors and the cargo to deter thieves.

The maritime bureau's report said the normal security guards for hire in Freetown "are generally unreliable and in many cases are little better than thieves."

The problem of 20th century piracy is not widely realized outside the maritime industry because most of the heists have been sporadic, small and covered by insurance.

The most dramatic incident was a multimillion-dollar piracy swindle in which an underwriting syndicate at Lloyd's of London was forced to pay $52.5 million to the Shell Oil Co.

In early 1980, the Liberian-registered supertanker Salem sank off the West African coast, supposedly carrying a cargo of oil from Kuwait to Europe. But evidence came to light that the Salem had been deliberately sunk by her own crew to hide the fact that nearly all her cargo of 196,000 tons of oil, valued at $56 million, had been covertly off-loaded at the South African port of Durban.

South Africa later agreed to pay Shell $30 million for the oil it had seized in defiance of an Arab oil embargo. But Shell sued Lloyd's, and a London high court ordered the insurer to repay Shell for the oil's full value.

Norwegians, Swedish Collaborate To Design Diving Habitat To Work in Waters to 500 Meters

The Norwegian Underwater Institute, Bergen, Norway, and Kockums Varv Shipyard, Sweden, have designed a new diving habitat, dubbed the Diving Mosquito. The self-propelled habitat chiefly would be used for the inspection, repair and maintenance of offshore production platforms and pipelines.

Designers say the system is more economical than utilizing purpose-built diving support vessels, particularly since the Diving Mosquito would have less downtime and can thus perform more tasks during the year. Kockums and the Norwegian Underwater Institute claim that a diving support vessel would be capable of working for only 35% of the year compared with 70% for the Diving Mosquito.□

SWEDISH ARM DOES WELL IN TESTS

First underwater tests of a Swedish manipulator system have been successfully completed at the Norwegian Underwater Research Institute in Bergen. There was 'no malfunction due to control hardware or software . . . all tools worked fine, and the only stop was for changing a piece of cable and a wedge in the arm, because of improper installation during assembly', according to Arnfinn Lindstad of the Systems Department of Oslo-based Central Institute for Industrial Research (CIIR).

CIIR has been responsible for developing the arm's unique control scheme, based on microprocessors and a simple joystick controller.

The Swedish firm Ingla built the arm itself with an extra function to allow the system to work behind both horizontal and vertical bracings. The arm's eight functions are: shoulder left/right, and foward/backward, upper arm rotate, elbow up/down, lower arm rotate, wrist up/down, grip rotate and jaw open/close.

Lindstad outlined to *OE* the tests so far. 'Aims of the trial were first to prove that the system could work reliably under water . . . we think the equipment functioned excellently', he says. 'Second, the test was an exercise in performing relevant underwater work tasks like sand/water jetting to clean steel, steel brushing, cutting of chain with grinder, mounting and unscrewing bolts and nuts, opening and closing gate valves, handle cathodic protection probe and ultrasonic thickness guage and concrete cutting the water jet.

'All in all, about 20 different tests were performed. All tests were observed by the manipulator operator through two TV cameras, making the work situation realistic.

'As an example, we managed to unscrew the last two nuts, dismount a 0.5m flange, mount it back (fixed bolts) and screw one nut back (with impact wrench) in 45 minutes'.

Cutting of concrete was done with 60% of the speed of a trained operator onshore, says Lindstad, and distances were measured within an accuracy of 1.5cm.

'The manipulator system was able to perform complicated work tasks even at this test state. The man-machine interface proved to be good — untrained operators could compete with a trained operator after one or two days'.

Now the institute is seeking to mount the arm aboard a remote controlled vehicle such as *Snurre* for sea trials this winter. Among the further developments envisaged are improvement of the precision of the arm — 'we aim within half a centimetre' — to improve further the control joystick and panel and to improve tool adaptors and develop a tool rack so that several different tools can be used in one work operation.

'We are designing and want to build a dedicated work system for an underwater vehicle', Lindstad sums up.

One atmosphere wellhead system

CAMERON Iron Works in Houston is expected to announce a site and an operator for the installation of its first one atmosphere wellhead system. It is believed the installation will be in relatively shallow water, probably in the Gulf of Mexico, where the concept can be tested thoroughly yet still be in diver depth for complete appraisal of the enclosure both inside and out.

Of particular interest will be the flowline pull-in equipment which allows for a wide degree of misalignment as well as electrical hook-up in the dry.

Engineers at the company have now refined the mark II version to a complete set of some 40 shop drawings which can be issued to any approved pressure vessel fabricator abroad. All the methodology of the construction and the welds has been approved by the highest certification society specifications likely to be encountered in a foreign oil province.

It is believed discussions have been concluded for the fabrication of the later version in Norway and if all goes well, deep water tests could take place in the Norwegian sector of the North Sea once the shallow water installation has proved the Cameron claims.

The company acknowledges that one atmosphere wellhead systems as a concept have probably been set back by Lockheed's misfortunes on the **Garoupa** field, but steadfastly believes the day of the one-atmosphere wellhead is rapidly approaching.

It bases its assumption on the high costs of retrieving a complete subsea tree for remedial work once production is required below normal diver depth. Even accepting the advances made by divers in atmospheric diving suits, the company contends there is no substitute for hands-on examination and maintenance by non-diving oilfield personnel. It points to the hot taps that were possible on the Garoupa field by the presence of skilled staff working in one atmosphere on a very tricky operation that would have been no less easier had it been on land. With a wet system, such an operation would have been almost impossible.

The Mark II Cameron system allows for any suitable submersible to land on and enter the chamber even if a drilling riser is attached to the surface. The chamber about to be placed has the hatch directly over the crown of the Christmas tree and is intended for TFL operation. If major remedial work were required the whole assembly would be pulled to the surface. All internal components break down to units small enough to pass through the hatch.

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

JULY, 1982

Vol. XV, No.2, Published by The Deep Submersible Pilots Ass'n

The Deep Submersible Pilots Association was formed in 1967 to provide for a free interchange of information relative to deep submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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1527 Linwood Street, Apt. 5
San Diego, CA 92103
(714) 295-0620

EDITORIAL NOTES AND COMMENTS

You may note from the above change in location of the "editorial office" to the city of Vacaville, next door to Travis Air Force Base and 45 miles from San Francisco, that your Editor has suffered an operational dislocation. I have relinquished the post of DSPA Secretary due to the practical necessity that DSPA officers be conveniently concentrated in one area. Don Saner is in the process of appointing an interim Secretary to assume the duties until the forthcoming elections. This follows on the heels of the departure of Treasurer Ron Rau and the appointment of Jerry Shiller to assume that duty.

John Donnelly of Woods Hole and ALVIN has offered to relieve me as Editor of this NEWSLETTER, and I propose to discuss such a change with him shortly. I think it is desirable that the Editor be more closely in touch with deep submersible operations and people than I can possibly be at this juncture.

We are happy to welcome on board as new Members Rear Admiral Brad Mooney, once a TRIESTE pilot and now Oceanographer of the Navy; Ensign Les Andrus of DSV TURTLE; and David Smith of PISCES 3 and 8, now with HMB Subworks, Ltd.

New regular attendees at our San Diego meetings are that couple, famous in oceanographic and other scientific circles, Ken and Jane Mackenzie.

During the ALVIN/LULU call at San Diego in February, I enjoyed a visit and discussions with pilots George Ellis, Ralph Hollis, and Bob Brown. George pointed out ALVIN modifications since last year's visit, including new 3-M 37 lb./cu. ft. syntactic foam, a second remote arm, oil-compensated cables, and a greatly improved data recording system which includes cassette tape recording of underwater photography. Excellent dive reliability has been established, estimated at less than 2% of dives unsuccessful due to materiel problems in the water.

George Ellis has left ALVIN and is with STRAZA in San Diego.

Bill Goldsby and Jerry Flaherty have moved from IUC to Oceaneering.

SECRETARY"S REPORTS AND NOTICES

Annual dues for 1982 are still owed by a number of Members. Please check to see that you have an '82 card. If not, pay up! If you have paid but have not received a card, get in touch immediately with Don Saner, Jerry Shiller, or Bob Worthington. Dues remain at $10.00 U.S. for USA/Canada mailing addresses or $15.00 U.S. overseas.

DSPA-San Diego Luncheon Meetings were held monthly this year. The February meeting was outstanding, setting as attendance record of 16 Members and 17 non-members. Guest of honor and speaker was RAdm Brad Mooney who has advanced from duty as a TRIESTE pilot to the prestigious position of Oceanographer of the Navy.-- At the May meeting, Frank Simpson of Lockheed Ocean Mining recounted the history of his company's long involvement in ocean miningdevelopment, leading to their present international consortium. He further discussed systems and problems, including the Law of the Sea Conference and legal aspects of ocean mining.-- At the June Meeting, Al Smith reported that DSV SEACLIFF had an encounter with her support vessel's screw during recovery. Damage was extensive, but no personnel injury occurred. The critical nature of the recovery operation was again demonstrated. The importance of experience, seamanship. and vigilance on the support vessel cannot be overemphasized

Elections will be held soon. Your nominations for a slate of DSPA officers should be forwarded to President Don Saner as soon as possible.

NEWS FROM MEMBERS

Hal Criger-CAN OCEAN(2/26/82)
"I told one of the guys in CAN OCEAN about the AUGUSTE PICCARD. He went to Mobile and found that the Project Manager was a fellow he used to work with years ago. He quit CAN OCEAN and went to South America to work with them on their treasure hunt. Wish them lots of luck, but it's not for me, unless there is something he knows and didn't tell me. Very busy last trip to Brazil, but it does make time go faster. Talked to a friend of mine at Santa Fe Construction, and they are purchasing a SCORPIO for their operations. Sure is a better vehicle than the R.C.V.'s, I'll tell you."

Kirk Newell-System Controls, Inc. (2/27/82)
"Next time you update the mailing list, please list me as Commander, USNR." (ED Note: Congratulations, Kirk! Keep in touch.)

Rick Slater- McClelland Engineering (3/7/82)
"Hope to make it down for a meeting one of these days. I haven't made a dive since ALVIN in 1980 but am still interested in what's going on"

John Donnelly-ALVIN (3/19/82)
"Although I had hopes of getting to San Diego for the DSPA luncheon, several meetings were scheduled this week to deal with planning for the replacement of R/V LULU. In spite of the fact that LULU has contributed to over 1200 successful ALVIN dives, her shortcomings are well known. She has performed far beyond the original concept and expectations. The plans for replacement are still on the early stages, but moving along very rapidly due to the projected ready for sea date of spring 1983. In capsule outline, ALVIN will be rigged for overhead lift, an A-frame hoist system will be installed aboard ATLANTIS II, and the ship modified to provide a hangar. Much work is yet to be done which indicates a very busy year ahead. We will keep you informed of progress from time to time. As to taking over responsibility of producing and issuing the NEWSLETTER, I would be happy to have further discussions."

Don Walsh-Institute for Marine and Coastal Studies (3/24/82)
"Don Keach and I are off again to the USSR this May to look at more programs in deep submergence and undersea engineering. We'll be in Japan for the UJNR meeting in Mid-May and then take the USSR ship BAIKAL from Yokohama to Nahodka (near Vladivostok) and then proceed across the Soviet Far East and Siberia to the Moscow-Leningrad area. The Soviets are still quite interested in developing some cooperative deep submergence scientific programs and have invited U.S. scientists to participate in cruises on board their ships where dives will be conducted with their two PISCES submersibles. In July, we go back to Japan for a couple of weeks to be present at the deep dive tests of the SHINKAI 2000 under the direction of the Japan Marine Science and Technology Center (JAMSTEC). I've enclosed a paper done by Mitsubishi Heavy Industries on the SHINKAI 2000 (they built it)."

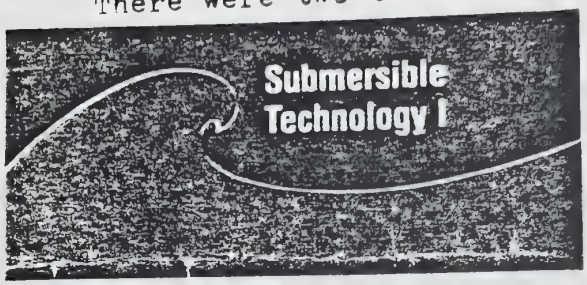
Gerard de Froberville-Conseil de Gouvernement de Polynesie Francaise (4/3/82)
"Thank you for the DSPA Newsletter which helps me keep in touch with the underwater world that I had to leave seven years agowhen ARCHIMEDE got short of money. My address should read as follows:..... Capitaine de Fregate (R)....(ED Note: I have lost track of Gerard's previous rank, but this should be a promotion. Congratulations!)

Larry Megow-Hahn & Clay (5/10/82)
"The 1982 Offshore Technology Conference, May 3-6, was another smash success, breaking all previous records. 108,160 people from 90 nationsattended the exhibition, breaking the 1981 record of 100,329. At the first OTC, fourteen years ago, less than 10,000 attended. In order to accommodate the 2500 firms from 24 countries who wanted to exhibit their wares, the exhibit areas were increased by 120,000 square feet to 625,000 this year.

The exhibits were fantastic. No official source put a value on the exhibits, but they ran into the hundreds of millions - could easily have reached a billion dollars. For example, there were 47 different companies advertising paints, coatings and linings; 42 companies exhibiting diving equipment; 46 showing offshore drilling equipment; more than 350 companies offering engineering, technical research and design services; more than 200 companies offering hoists, cranes and derricks; several hundred with new and difficult instrumentation applications - a total of more than 6,500 different products or services.

There were two technical sessions on submersibles.

MONDAY



Presiding Chairmen:
John A. Pritzlaff, Westinghouse — Oceanic Division
Carol Pritzlaff-Elliot, Westinghouse Field Engineering

OTC

4180 Ten Years of Operational Experience with CURV III
A.J. Schlosser and L.K. Brady, Naval Ocean Systems Center

4181 The Evolution and Design of a Force Balanced ROV
C.J. Nicholson, Benthos Inc.

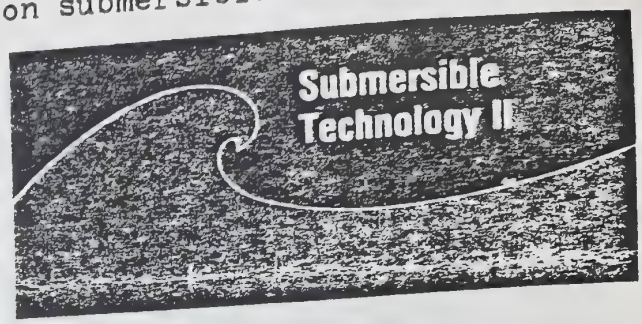
4182 A Non-Buoyant ROV for Performing Heavy Sub-Sea Work
P.J. Thingstad and H.D. Hveding, Myrens Verksted A/S

4183 On the Development of Japanese 2,000m Deep Submergence Research Vehicle 'SHINKAI 2000' System
Y. Hamada and S. Takagawa, Japan Marine Science and Technology Center; T. Ikeda and M. Sunaga, Kawasaki Heavy Industries Ltd.; M. Endoh and K. Yokota, Mitsubishi Heavy Industries Ltd.

4184 The Design of a One Atmosphere Submersible/Diving System
J.R. McFarlane and M.D. MacDonald, International Submarine Engineering Ltd.

SESSION SUMMARY The first session on submersible technology contains a cross section of international papers on unmanned and manned vehicles. The first paper discusses 10 years' operational experience with the unmanned CURV vehicles of the Naval Ocean Systems Center in San Diego. System mobilization, transportation, operational success, and some operational failures are reviewed. The second paper describes a Norwegian nonbuoyant, unmanned work vehicle called SPIDER. One SPIDER has logged more than 7,000 operating hours. Heavy equipment placement and heavy-duty work tasks are the specialty of these cable-suspended vehicles. The next two papers bring into focus the design and construction aspects of large and small manned vehicles. The development of the 3-man, 25-ton DSV SHINKAI 2000 is presented by the Japan Marine Science and Technology Center. Major vehicle subsystems such as pressure hulls, batteries, and titanium pressure vessels are covered along with details of the handling system and the specially designed support ship NATSUSHIMA. The final paper discusses the use of a microprocessor control system to provide automatic heading and depth control in either manned or unmanned operating modes.

TUESDAY



Presiding Chairmen:
Howard R. Talkington, Naval Ocean Systems Center
M. S. Macovsky, Westinghouse Defense and Electronic Systems Center

OTC

4277 Experimental Assessment of Manipulator Performance with Particular Emphasis on Tool/Work-Object Interface
I. Datta and C. Kuo, U. of Strathclyde

4278 Choice of Umbilical Cable for Submersibles Footprint Optimization
G. de Wit, Marcon (Marine Consultants) BV

4279 Specialized Deepwater Drilling Support - Remotely Operated Vehicle
P. Nellessen, Oceaneering International Inc.

4280 A Tethered Submersible for Use as a Tool by a Diver
G.E. Marsland and K.H. Marschner, ZF-Herion-Systemtechnik GMBH

4281 Control System and Hydrodynamic Analysis for TUMS (Towed Unmanned Submersible)
P. Rusnfeldt, Perry Oceanographics Inc.

4282 Protecting Submarine Cables from Accidental Damage
K.W. Tate, Naval Civil Engineering Laboratory; W. Tudor, Naval Facilities Engineering Command; and R. Eaton, U.S. Department of Energy

SESSION SUMMARY The application of advanced technology to systems that perform work in the ocean is providing safer and simpler means to conduct undersea operations. The first two papers in this session concern the application of computers to develop and assess the means to increase manipulator capability and to optimize choice of umbilical cable configurations. The next two papers describe two new tethered vehicles, one tailored to work with deep drilling operations and the other to operate as a diver's tool. The next paper discusses the control system and hydrodynamic analysis for the Towed Unmanned Submersible (TUMS) being developed for the British Royal Navy. The final paper provides an analysis of hazards to cables placed on the seafloor and an assessment of cable protection technology.

Bill Goldsby-Oceaneering Int. (6/17/82)
"At the time I joined DSPA a few months ago, I was working for IUC on the PISCES VI on board the drill ship DISCOVERER SEVEN SEAS. I am no longer with IUC. At present, I am working for Oceaneering International Advanced Systems Group. We are working for Phillips Petroleum in their Espoir Field off Abidjan, Ivory Coast, Africa. I don't know how long the team will be here; I am employed out of Oceaneering's Houston office. In the past, Ihave had no correspondence or newsletters from the Association except for the first packet with my letter of acceptance. I believe that you have been sending my mail to the IUC New York offices and they have not been forwarding it to me. In the future, would you please send correspondence to me at my home addree. This would insure faster delivery to me wherever I may be as my wife always knows how to reach me. I thank you for this as I very much want to keep track of what is happening with working submersibles and their people around the world."
(ED Note:Please advise me promptly when your addresses change. You would be surprised at the amount of postage we waste.)

A San Diego scientist who has worked from the world's highest mountain range to the ocean's depths has been selected by the National Science Foundation (NSF) for the first Special Creativity grant to be given to an oceanographer.

Dr. Harmon Craig, geochemist and head of the Isotope Laboratory at Scripps Institution of Oceanography will receive $175,000 a year for two years, a total of $350,000.

"Creativity awards provide several years' funds for especially productive scientists to explore new scientific opportunities related to their areas of ongoing research. A creativity award recognizes a long track record of high productivity and the promise for continued excellence in one's research," said UC San Diego Chancellor Richard C. Atkinson.

"This award is given to a limited number of scientists who have consistently made major contributions to scientific progress."

Special creativity awards were created by Dr. Atkinson in early 1980 while he was director of NSF. The award allows scientists to pursue their research without having to resubmit proposals each year for funding.

The grant will be used by Dr. Craig to fund expeditions and related research on gases in hydrothermal vents on the sea floor and for research on air-sea interaction and oceanic circulation and mixing processes, which are important for predictions of the atmospheric carbon dioxide increase.

The Tinker Foundation has awarded a three-year, $270,000 grant to Scripps Institution for expansion of a scientific exchange program in oceanography with Latin American countries. The scientific exchange will be accomplished through scholarships for master's degree candidates, support for visiting scholars, and numerous reciprocal visits for marine science lecturers at United States and Latin America institutions and laboratories. The program is the largest of its kind to receive Tinker Foundation support and is an extension of Scripps' highly successful exchange program with Mexican universities and marine science laboratories.

Scientists participating in a National Science Foundation-funded expedition in the Guaymas basin area of the Gulf of California, report finding extensive yellow, white, and orange bacterial matting on rocks and on the sea floor and an abundance of large red crabs near deep-ocean hot springs. The springs, or hydrothermal vents, also contain patches of "young" petroleum, which have been formed in thousands, rather than millions, of years through the pressure-cooker-like conditions of high temperatures and high pressure at these mile-deep sites. Chief scientist for the expedition was Dr. Peter Lonsdale, a geologist at Scripps Institution. ■

An Invitation to participate in the NOAA Caribbean Regional Undersea Program

Since November 1977, the Caribbean Regional Undersea Research Program at St. Croix, U.S. Virgin Islands, has operated as one of 4 NOAA-sponsored regional undersea programs designed to improve our ability to understand and manage marine resources. The research facilities are managed by the West Indies Laboratory of Fairleigh Dickinson University under contract to NOAA, and are located on the north coast of St. Croix. These facilities consist of a manned saturation habitat which houses up to 4 saturated diver/scientists, a life support buoy and shore-based operational and lab facilities. The underwater laboratory is located at a depth of 50' at the head of Salt River submarine canyon, with rich tropical biota and reef systems. To date, 45 scientific missions, usually of seven days duration, have made use of the extended diving time and intensive work schedules made possible by saturation diving techniques.

This is an invitation to submit proposals for the period January 1, 1983 through September 30, 1983 for the use of this unique underwater facility. A strong emphasis will be placed on integrated programs of national significance, stressing research with clearly-stated practical applications. Proposals may fall into one or more of the following categories:

1. Fisheries resource management and conservation.
2. Assessment of the effects and significance of marine chemicals, including those that are biological active or that have corrosive properties.
3. Assessment of marine geological resource and processes, including those related to energy reserves and marine minerals.

As in the past, proposals will be evaluated using the scientific peer reivew process. The peer review panel will seek projects leading to definitive conclusions with practical applications. Each proposal must clearly demonstrate the need for the use of the laboratory facility and especially saturation diving techniques. High priority will be placed on productivity, and the results from these concentrated efforts may be drawn together at the end of 1983 in a special publication with national visibility.

In some cases, several different investigators may wish to use a common resource, such as artificial reefs in a coordinated study of diverse aspects of one project. The program will consider groups of coordinated proposals which may involve different investigations in a sequence of integrated missions or possibly repeated missions by individual teams. Proposals may be submitted singly, or several proposals may be submitted as a group with one investigator designated by the applicants to be responsible. In the case of multiple-project or multiple-mission projects, each project (or mission) should be justified individually and its value to the overall project should be stated (i.e., do you feel your multi-disciplinary project is an "all-or-nothing" venture, or would certain parts of it be sufficiently valuable to stand on their own?).

The use of the Underwater Laboratory System will be provided at no cost to the scientists whose proposals are selected. Limited funds are available for transportation. Salaries for the participants and research expenses will be provided by the participant's parent organization. Investigators wishing to submit proposals or who need further information concerning proposal submission should contact:

Mr. William Busch
NOAA (RD/SP2)
6010 Executive Blvd.
Rockville, MD 20852
(301) 443-8391

or

Dr. John C. Ogden
P.O. Box 4010
Christiansted, St. Croix
U.S. Virgin Islands 00820
(809) 773-3339

The deadline for proposal submission for missions during January 1, 1983 through September 30, 1983 is August 31, 1982.

Westinghouse Delivers New Navy Search System

The U.S. Navy's new Surface Towed Search System (STSS) has been delivered and has undergone successful initial sea trials in the Pacific. Trials will continue intermittently for several months. Developed under contract by the Oceanic Division of Westinghouse Electric Corporation, Annapolis, Md., the STSS provides a capability to search for, locate, classify and identify objects on the ocean floor at depths to 6100 meters.

The STSS and its motion-compensated towing system have been installed on the *Energy Services-1 (ES-1)*, a modified offshore supply boat. A large handling system also has been installed for launch and recovery of the Navy's deep submergence vehicles *Sea Cliff* and *Turtle*. *ES-1* and the manned and unmanned submersibles are to be operated by the Submarine Development Group One, San Diego, whose mission often requires quick location and recovery of aircraft, weapons and other valuable equipment lost at sea.

The STSS provides a general deep-ocean search capability. It consists of a towed vehicle equipped with side-look sonar, TV and still photo cameras. A forward looking sonar provides for obstacle avoidance.

In a typical mission which requires location of objects such as aircraft wreckage, the STSS would be deployed for large area search operations. In long range mode, the side-look sonar can cover nearly 12 square miles per day at a 1.5 knot tow speed. Once an object is detected, the vehicle is navigated for TV and photo documentation. These and other records are then used to plan recovery of the flight recorder or other equipment by deep ocean manned submersibles such as *Sea Cliff* or *Turtle*.

Navigation of the vehicle is accomplished by using a field of deep ocean transponders which permits area navigation of both ship and vehicle. The plotted positions provides the basis for tow control actions. Parallel lane search will be the normal STSS tow pattern.

Westinghouse designed and produced the side-look sonar which can be tuned for detection of small objects or for survey and mapping of large bottom areas. Display is real time on a standard CRT monitor. Areas of special interest are documented on magnetic tape recorders.

Object classification and identification are accomplished by slow scan television and 35mm photo camera. A Westinghouse WTC-41 low-light level TV camera also serves as a real-time view finder for the still photo camera which provides the principal end product of a search and location mission. The TV has a 30° by 40° field of view.

The film camera is a Model 1003 made by Vinten, Ltd., of England and put into a special pressure housing developed by Westinghouse. Film capacity is either 3500 or 5600 frames, depending on the type of film used. Frame rates are variable so that stereo can be achieved. The forward-look sonar is a continuous transmission frequency modulated (CTFM) made by AMETEK, Straza Division. It essentially is a Model 500 adapted for deep ocean operation.

Westinghouse also produced the altitude sonar for the vehicle which can measure from 76 cm to 76.2 m above the bottom. Accuracy is within 1% or 15.2 cm whichever is greater.

The STSS vehicle itself is 4.27 m long and 0.6 m in diameter. It weighs 1134 kg in air and 317.5 kg in water and is designed to tow stably at low speeds.

The towing system includes a hydraulically operated traction winch and storage reel which accommodates 9144 m of 1.8 cm double armored tow cable, a motion compensated towing boom and an adapter assembly which rotates the towing boom for vehicle pick-up launch, and towing position. The vehicle itself can be launched or recovered while beneath the water's surface. The launch/recovery/towing system was designed under subcontract to Westinghouse by Techwest Enterprise, Ltd. of Canada. It was built by Techwest and Heede International, also of Canada. These companies also designed and built the Remote Unmanned Work System (RUWS) motion compensated system for the U.S. Navy.

All launch and recovery operations including control of the cable winch, adapter, boom and head sheave rotations are controlled from a local console mounted close to the adapter and boom assembly. After the vehicle has been launched the operator may transfer to remote control of winch and boom in the operations shelter.

Two shelters are provided for the STSS. One houses the vehicle for maintenance and repair; the other is the operations shelter where the STSS is controlled and its sensor data are displayed and recorded. The system requires three operators, one each for the navigation, search and towing functions.

Two TV monitors provide real time display of port and starboard side-look sonar. Two tape recorders are provided, one for permanent side-look sonar record, the other for playback during the search.

The TV scene is displayed as slow scan TV and there is a video tape recorder for permanent record. A microprocessor controls the flow of annotation data to the sonar, TV displays and recorders and to the film camera. Built-in-test (BIT) capability is provided for all major vehicle functions.

Myrens Verksted Offshore Division Introduces New Submersibles

Myren Sub Sea, the offshore division of Myrens Verksted A.S., has introduced the Mark 2 version of the company's *Snurre* remotely operated submersible system. The first of the new vehicles, designated *Snurre 2*, was developed as a completely modular unit and had been ordered by Intersub for delivery last month.

The new modular design was developed to provide fast interchanges within the vehicle's main electrical and hydraulic power and control systems, infinite adjustment of buoyancy to meet differing payload and operating conditions and straightforward fitting of tools and equipment using the vehicle's new fully self-contained "bolt on" tool carrier assembly.

Law Of Sea Talks Move Into Showdown Session

By ANDREW RADOLF

How to mine the ocean's mineral wealth for the "benefit of mankind as a whole" will be the chief subject of negotiation when the United Nations Conference on the Law of the Sea convenes tomorrow for its 11th, and hoped-for final, session in New York.

Diplomats from 150 countries have been working on the treaty since 1973.

After nearly a year-long "comprehensive review" by the government, the White House on Jan. 29 issued a statement by President Reagan, saying the United States "accepts" most of the treaty but has "serious questions" about its provisions governing deep seabed mining. The President said that if the "key objectives" of the U.S. in seeking revisions are met, "then my administration will support ratification."

The Law of the Sea was negotiated as a "package" balancing the economic and strategic interests of the West, Eastern Bloc and Third World. In 175 pages and over 440 articles, it states rules, regulations, rights, conventions and procedures for just about every type of commercial and military activity over, on and under the waves.

In its major parts, the Law of the Sea:

— Sets territorial waters at 12 nautical miles from shore and establishes a "contiguous zone" of another 12 miles for a coastal state to "prevent and punish infringement of its customs, fiscal, immigration, or sanitary laws."

— Declares "all ships and aircraft," including military planes and naval vessels and submarines, "enjoy the right of transit passage, which shall not be impeded" through the straits used for international waterways.

— Gives coastal states an "exclusive economic zone" of 200 nautical miles with "sovereign rights" to all "living and non-living resources," including oil and minerals of the seabed. Under this provision the U.S. has "primary" responsibility for managing ocean fishing of stocks such as salmon which spawn in its rivers. In the case of "highly migratory species" like tuna, the treaty requires nations to "cooperate" for "optimum utilization."

— Allows countries to claim exclusive rights to all the resources of the outer continental shelf to a distance of 350 nautical miles. The continental shelf and economic zone provisions have gained prominence with the discovery last year of polymetallic sulfides off the coasts of Washington and Oregon from 70 miles to 300 miles out to sea. These sulfides, left by superheated water escaping from "black smokers" on the ocean floor, contain copper, lead, zinc and other ores "in concentrations greater than on land." U.S. ocean geologists have also found deposits of polymetallic sulfides in the Pacific rise off the coast of Mexico and near the Galapagos Islands, which are part of Ecuador.

— Requires states to protect the ocean environment and empowers them to enforce their anti-pollution laws.

— Defines international guidelines for marine research.

— Establishes an international court system for adjudicating ocean-related disputes between states.

It is in the creation of the Deep Seabed Authority and its commercial arm, the Enterprise, that the Law of the Sea treaty contains its most ambitious, most futuristic and most controversial passages.

Declaring the mineral wealth of the deep seabed to be the "common heritage of mankind," the treaty gives the Authority broad powers to determine who will mine the ocean floor and where, and to limit production of ocean minerals to protect the interests of land-based producers.

Under the treaty, firms wishing to mine the deep seabed must draw up two sites of equal commercial value. One of those the sites the Authority "reserves" for mining by the Enterprise, with a share of the net proceeds going to needy developing countries. The other site the Authority makes available for private development.

This "parallel system" resulted from a compromise between the developing world's demand for a means of actually participating in ocean mining operations and the West's need for an "international regime" giving legal security to private investments in deepsea ventures.

Most of the proposed mining will be for metallic nodules consisting of manganese, copper, cobalt and nickel which carpet the sea floor at depths up to 16,000 feet. Mining companies say it will take a minimum investment of $1 billion to begin exploiting deep seabed mine sites, which can cover 18,000 square miles or more. The richest known area for potential mining of nodules is the Clarion-Clipperton zone in the Pacific Ocean between Mexico and Hawaii.

At the Law of the Sea conference's session last August in Geneva, the chief U.S. delegate, Assistant Secretary of State James Malone, stated the administration's objections to the treaty. It fails to assure that all qualified applicants will be granted permission by the Authority to mine the sea floor, he said, "creates a situation in which the Enterprise, using funds provided in part by the U.S. government, eventually would eclipse mining activities by private companies," and "imposes significant regulatory and financial burdens" on mining companies through the Authority's power to limit production of ocean minerals.

Radolf is a New York-based free-lance writer, specializing in the United Nations.

Maritime Treaty Passed Despite Dissent By U.S.

From The San Diego Union's News Services

UNITED NATIONS — An international law of the sea treaty was adopted by a huge majority yesterday, despite U.S. opposition over regulations on deep-sea mining. The treaty had been eight years in the making.

Third World nations provided the voting clout to ratify the treaty, with the United States finding itself in an isolated group that rejected the code. The final vote was 130 to 4.

Seventeen nations, a combination from the European Economic Community and the Soviet bloc, abstained in the voting by the U.N. Conference on the Law of the Sea.

The treaty, controlling everything from the free passage of ships and planes to the exploitation of the ocean's wealth of oil, gas, fish and metals, will come into force when it is ratified by 60 nations. But it is unclear how effective it will be without the United States and the possible absence of such industrial powers as West Germany, Britain and the Soviet Union, all of whom abstained.

Conference President Tommy T.T.B. Koh of Singapore had hoped the treaty could be adopted by consensus, but deeply felt disagreements — which continued despite last-minute attempts to compromise with the United States — prevented such unanimity.

The U.S. delegate, James L. Malone, then pressed for the recorded vote to the dismay of Asians, Africans and Latin Americans. They had hoped the code would be approved without formal opposition or abstention, but Malone's action forced each nation to take a public stand on the issue.

Malone acknowledged that the final two months of bargaining had brought about some "modest improvement" in the rules for mining metal nodules in the seabed, the sole concern of the Reagan administration. But it wasn't enough, he told a disheartened conference.

Malone contended the treaty would "deter the development of the deep sea ... resources," a complaint originally voiced by U.S. firms engaged in developing the technology needed to mine the seabed.

The sea law treaty is designed, among other things, to ensure that Third World nations — which do not have the technology to exploit the mineral wealth in international waters — would share in the riches of the sea.

Mining companies engaged in exploratory efforts to suck up the copper, cobalt, nickel and manganese on the Pacific floor estimate that no commercial production can start until 1995 at the earliest.

The American envoy acknowledged that the code, thanks to the last round of bargaining, would protect the financial investments of American and other firms already at work.

But, he complained, it doesn't guarantee that still other U.S. miners can exploit the seabed.

Perhaps the key U.S. objection was constitutional. As Malone said, the treaty allows "amendments to come into force for a state without its consent." The code will enable three-fourths of the treaty signers to impose amendments, overriding the U.S. constitutional provision requiring Senate assent.

Finally, the U.S. delegate said the treaty sets unacceptable precedents. He noted that its cartel feature, fixing mining limits to protect prices, would be "a key problem for the U.S. Congress." Malone also mentioned another major stumbling block, the demand that private concerns or their governments sell technical know-how to a global mining enterprise.

The cost of this enterprise is believed to be the key reason for the abstention by the Soviet Union and its allies. The United States would have paid 25 percent of the burden but now this large share must be distributed among the other states.

They hope that this is not the last word from Washington, that a new administration will take a different view and someday ratify the treaty.

The other principal industrial nations engaged in seabed mining divided on the code. France and Japan voted in favor; Britain and West Germany abstained. Paris, London, Bonn and Washington have been considering a treaty of their own to carve up the seabed but Third World nations will now challenge in international courts any mining undertaken outside the treaty.

The three nations that voted with the United States against the treaty were Turkey, Venezuela and Israel.

Elliott L. Richardson, the former chief U.S. delegate to the conference, called the result "a bad outcome."

UNESCO Joint Panel Urges Standardization in Research

The UNESCO/ICES/SCOR/IAPSO Joint Panel on Oceanographic Tables and Standards has recommended the adoption of a Practical Salinity Scale, 1978 and a corresponding new International Equation of State of Seawater, 1980. A full account of the research leading to their recommendation is available in the series UNESCO Technical Papers in Marine Science.

The parent organizations have accepted the Panel's recommendations and have set January 1, 1982 as the date when the new procedures, formulae and tables should replace those now in use.

So far as users are concerned, little is needed except the use of the new International Oceanographic Tables or equations. These, together with an explanatory introduction, will be made available by the UNESCO Division of Marine Sciences as soon as possible.

All oceanographers are urged to use the new tables or equations for work reported on and after January 1, 1982. They should note in particular that the use of the new International Equation of State of Seawater, 1980 requires the use of salinity values determined on the Practical Salinity Scale, 1978. To avoid confusion, authors and editors are particularly requested to ensure that during the period of change, published values are accompanied by an indication as to which tables or equations have been used in their determination.

Harbor Branch Scientists Discover Algae Growing at Record Depth

Scientists and technicians diving off the coast of the Bahamian Island San Salvador in a Florida-based submersible discovered algae growing at levels that are reportedly new depth extensions for any type of algae.

Operating from the decks of *R/V Johnson*, a Harbor Branch Foundation research vessel and submersible support ship, the crew found areas in the Bahamian waters to be "incredibly" clear at great depths. In a series of dives (including one lockout dive) from November 13-17, 1981, Dr. Nathaniel J. Eiseman and Robert A. Gibson discovered the deep water algae that testified to the sea's clarity—the cholorphyll bearing plants cannot survive without sunlight and light does not normally "reach" to the depths where several species were found.

While guiding *Johnson-Sea-Link I* through "crystal clear blue water," the pilot once reported "excellent" visibility ranging from 200 to 300 feet from a depth of 600 feet. At final count, the recently discovered algae *Johnson-Sea-Linkia* was located at a record 660 feet, and a crustose red algae was collected from a depth of 810 feet.

SUBMERSIBLE NEWS AND VIEWS

from IRENE FAGER

International Underwater Contractors, Inc. has named veteran U.S. Navy Diver Ray Curran as head of its Gulf Coast Operations. Curran spent 29 years in the Navy, most of that time in various aspects of underwater work, as a helium/oxygen deepsea diving officer, as an ADS-IV saturation diving officer, and as a medical corps officer.

IUC also has announced that it has bought the MANTIS DUPLUS, which was written about in last month's newsletter. This MANTIS will have a depth capacity of 2300'.

Solus Ocean Systems Awarded Rig Support Contract By Phillips

Solus Ocean Systems, Inc., Houston, Texas, has been awarded a 15-month contract by Phillips Australian Oil Company to provide underwater services in support of the rig Diamond M Epoch.

Solus will provide one of its dual Hydra vehicle systems which consists of a cage deployed, hydraulically powered, unmanned tethered submersible fitted with two manipulators, together with a second vehicle to provide total back-up.

Oceaneering International, Inc. has announced the appointment of Paul E. Gillen as General Manager of the firm's West Coast Division. Also named to the West Coast Division is Richard A. Livingston as Sales Engineer.

Oceaneering has completed a project to install a new fendering system and provide related services for an offshore terminal owned by West Indies Oil Company, LTD. on the island of Antigua in the Caribbean Sea.

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Now a note from Can-Dive Services, Ltd., which is a subsidiary of Oceaneering. Phil Nuytten, President of Can-Dive, writes that he is literally swamped with covers meant for the BREADALBANE Expedition. This was to involve SEA OTTER, WASP-1, and a bell. The expedition had to be cancelled when the ice broke up. They do plan to try again in March/April of 1983.

Mr. Nuytten also noted that they had just completed a major refit on the SEA OTTER, including the installation of an ISE 5-function manipulator. This was an interesting swap-around as the ISE arm was originally on their manipulator bell AW-1 (formerly the D.D.S. CONSTRUCTOR). They removed it and put it on SEA OTTER with a self-contained outside package for controllers/hydraulic pump/battery power, etc. On the AW-1 they mounted a much larger manipulator that was formerly built for the BEAVER MK IV (now at IUC) by Autonetics Inc.

SEA OTTER pilots are Terry Thompson and Doug Huntington. WASP pilot is Doug Osborne and pilot/technician is Tom Gilchrist. WASP-1 has been working on underwater photography for Walt Disney Studios at Little Cayman Island...pipeline completions, aircraft salvage, oil-rig wellhead work, etc.

Can-Dive is just finishing up a large saturation system to be shipped to Japan in July. This will be installed on a drilling rig that will be used offshore Eastern Canada in 1983. Project Manager is Jim English and Darryl Baker is lead saturation Supervisor.

As the letter was being written, Mr. Nuytten said they had a team in saturation aboard the NEDDRILL 2, offshore St. John's, Newfoundland, working on the sunken rig OCEAN RANGER, shutting in the well, removing the BOP stack, etc. Project Manager is Doug Elsey of the Toronto office.

Also...congratulations to Mr. Nuytten on his election as President of the new Canadian Association of Diving Contractors (CADC).

Ride in a submarine

Vancouver Island scuba divers can now go down into the ocean depths by themselves in a one-man wet submarine that may be rented by the day and soon may be available for individual purchase.

Guy Gaudreau of Scorpion Professional Welding and Diving in Parksville has the franchise for the tiny submarine which has a 500-pound lifting capacity and cruises four to five hours at five miles an hour.

It is trailerable and can be used by sport divers or for light salvage work.

It operates when full of water and the operator wears a scuba diving outfit and may vacate the submarine underwater for a look around the ocean bottom and then return to the sub for more underwater cruising. Air supply last 50 per cent longer in the sub because there is no exertion.

Gaudreau plans to manufacture the sub on Vancouver Island and expects it will then sell at around $4,500.

JERED Purchases First of New Undersea Vehicle Class

JERED, Inc., the Houston-based unmanned vehicle service company, has purchased the first of a new class of underwater vehicle systems for the offshore industry.

The vehicle, called Recon-SJ, is being manufactured by Perry Oceanographics. The new system will have the capability to carry and deploy payloads in excess of 182 kg weight.

The vehicle is based on a design owned by Shell Oil that modifies the basic Recon-J systems used extensively the past year by JERED.

Bill High writes that PROJECT SEA SUB 382 will commence in Seattle on July 7, 1982. NEKTON GAMMA will be transported to Kodiak, Alaska to dive for 3 weeks doing fish research. They estimate 40 plus dives, 200' to 1,000'.

Mr. Thomas G. Vetter, Special Projects Manager of NEKTON, Inc. wrote with an up-date on that company's activities.

Since Sept. 1981, NEKTON GAMMA has performed over 100 dives in a chain of operations off Southern California. These dives have involved: 1) a proprietary study of natural oil and gas seeps and their seismic responses for a consortium of oil companies. 2) a study of oil and gas seeps for the State of California. 3) a biological survey of a 6 square mile area in preparation for offshore oil exploration. and 4) a survey of anchor scars, created by a pipeline lay barge, which interfere with shrimp fishing in the Santa Barbara Channel.

NEKTON not only performed the submersible field work, but also wrote some 1000 pages of scientific reports.

Mr. Vetter also notes that the NEKTON GAMMA will be going to Alaska. NEKTON ALPHA will be going to Michigan to inspect a gas pipeline crossing the Straits of Mackinac.

Pat Grandemange writes that the Intersub submersible PC 1201 has just carried out a contract on the Casablanca Field off Tarragona, Spain. The PC 1201 operated from the support vessel NADIR and the work consisted of pipeline survey and cathodic protection measurements.

The University & The Sea
Texas A&M University • A Sea Grant College
Vol. 14, No. 4 • Winter 1981

Flagship of Texas A&M's oceanography fleet takes part in search for fabled TITANIC

The Research Vessel GYRE hovered over a trench deep in the cold waters of the North Atlantic. Somewhere two miles below lay the hulk of a luxury ocean liner asleep almost 70 years.

Within the massive bowels of this "floating Babylon" are the ghosts of 1,500 of the 2,200 who booked passage from Liverpool to New York, the poor, the rich and the very, very rich-Guggenheim, Starus, Astor, Ismay, captains of industry, their families, and the entourage they carried while traveling the world. Making her maiden voyage, the TITANIC went barreling across the North Atlantic at very near her maximum of 21 knots (following the custom of that period of punctual arrival above all else).

In the dead of night across an unknown icefield in an impenetrable fog, this thrusting mass hurried onward with little thought of the impossible, the unthinkable. Within the TITANIC's 900 feet of steel hull were 16 water-tight compartments. The ship's builders had boasted that any compartment damaged could be sealed off and the remaining compartments would keep TITANIC afloat. They called her unsinkable.

Experts would say later that had she hit the iceberg straight on it's likely she would have survived. But moments before impact, and seeing the foggy image of the mass of ice dead ahead, the ship's watch ordered an abrupt turn. TITANIC struck the ice a glancing blow, ripping a gash 300 feet long along her starboard side just below the water line. It was April 12, 1912, 11:40 p.m. In less than four hours, as the 750 who survived watched from the pitifully few lifeboats, the stern lights went out, the last of the doomed entered the near-freezing water and TITANIC began her express ride to the floor of the Atlantic two miles below.

What was a scientific party—oceanographers—doing searching for the wreckage of TITANIC? Better question: What was the GYRE, flagship of Texas A&M University's Department of Oceanography research fleet, doing there?

Those aboard the GYRE were trying to pinpoint the ship and, perhaps eventually, recover millions of dollars worth of treasure—art, jewelry, maybe contraband—sealed inside the TITANIC.

And the GYRE? The GYRE was doing what she does best, albeit this mission was somewhat out of the ordinary.

It all started months before when Texas oilman-geologist-adventurer Jack Grimm leased the GYRE for two weeks last summer in his quest to recover the incalculable treasure listed on TITANIC's manifest (and anything not manifested). Of particular interest to Grimm is an exceptionally rare copy of the Rubiayat of Omar Khayyam.

"It is jewel-encrusted and took two years to assemble. I know it was aboard," Grimm said from his Grimm Oil Co. offices in Abilene only days before his party left for the North Atlantic.

If he is to recover the Rubiayat or any other gem from the TITANIC, Grimm will have to finance another search because, for the second year in a row, bad weather and time ended last summer's search. But while the primary goal remains unattained, other accomplishments were made.

In 1980, Grimm ordered and financed the design and engineering of a sidescan sonar, a device to map the contours of the ocean floor. Previously such equipment was limited to a swath of about 6,000 feet with each pass. Grimm's sidescan sonar can map a swath of 15,000 feet, greatly increasing the speed and scope of contour mapping.

The faster sidescan was a key factor while working in the North Atlantic where the "window" of favorable working weather is limited to less than three weeks in mid-summer.

Grimm, a graduate geologist from the University of Oklahoma, has donated his sidescan sonar to Columbia University.

The GYRE gained experience with the improved sidescan after Grimm's 1980 search for TITANIC. The United States Geological Survey (USGS), skeptical of the sidescan's initial test results, hired the GYRE and mounted the sonar on her hull for further tests in the Gulf of Mexico. The tests onboard GYRE subtantiated those made earlier in the North Atlantic. Predictably, the offshore petroleum industry is excited about the device's wider scanning ability and reduced contour mapping time.

The 1981 TITANIC search saw a second contribution to oceanography—the discovery and plotting of an ocean-bottom canyon 20 miles long, 1 mile wide and 200 feet deep, subsequently and suitably named Titanic Canyon.

It is noteworthy that a ship the size of the GYRE, moderately sized as research/oceanography vessels go, would be chosen and would be capable of the work load for an undertaking like the search for the TITANIC. The reasons are her design—she's sparse but clean and comfortable—and her big-job capability and low operating cost. GYRE can match the science work load of ships far larger and heavier at about half the operating expense. ■

New Sub to Be Used in Titanic Search

RICHMOND, Feb. 22 (UPI) — A leader of the effort to locate the sunken British ocean liner Titanic in the depths of the North Atlantic said today that the exploration team would resume the search in 1983 with an aluminum submarine.

Arthur Markel, a scientist at Reynolds International Services Inc. of Richmond and captain of the ship, the Aluminaut, said the team was undeterred by several unsuccessful efforts to find the ship, but cannot continue the search until next year.

"We can't get out any sooner than the summer of 1983 because we're taking the submarine for the first time," Mr. Markel said in a telephone interview. "It will take that long to get it ready."

Mr. Markel, of Midlothian, Va., is a member of a team hired by Jack Grimm, a Texas oilman, to search an area in the North Atlantic off Newfoundland, Canada, for the vessel, which sank on its maiden voyage in 1912.

Using sonar scans in 1980 and 1981, the team failed to locate the ship in the 300-square-mile area that is believed to be its resting place.

JUL 82

International Underwater Contractors, Inc. announced that its submersible and diver-support vessel, ALOHA, has had a four-point anchoring system installed to expand its deepwater work capabilities in the Gulf of Mexico. The 143' long specially designed ship can remain on station in support of divers, submersibles, and ROVs. The addition of the four-point anchoring system to the ALOHA's continuous slewable bow thruster results in a combination that provides flexible and dependable underwater support.

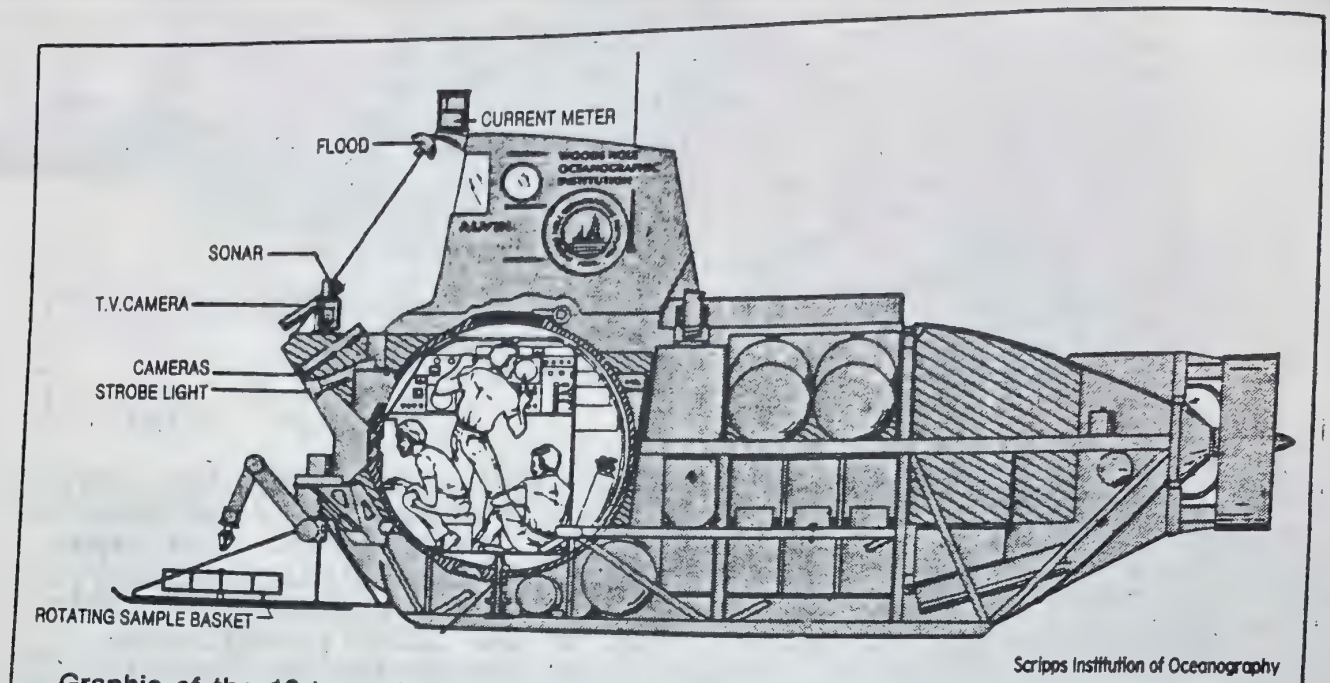
Gib Blevins, Jr. has been promoted to Senior pilot for Oceaneering and George Brotchi has received a promotion to Crew Chief of Ocean ARMS Bell I.

Chuck Collins has left Oceaneering International, Inc. and is now with International Submarine Engineering in Canada.

In the Oct. 1981 issue on page 89 I wrote about a cover I had received from Ron Barnard telling about discovering a mine at the COMORANT A rig. I asked him to tell us more about it and here is his reply: "The statistics on the mine were; Type - MK 17; Fired - Influence; Charge - 320-500 lb Amatol or T.N.T.; Dimension - 40" diameter, 50" length, 81" belly band; Weight in air - 1200 lbs; Laid - surface craft.

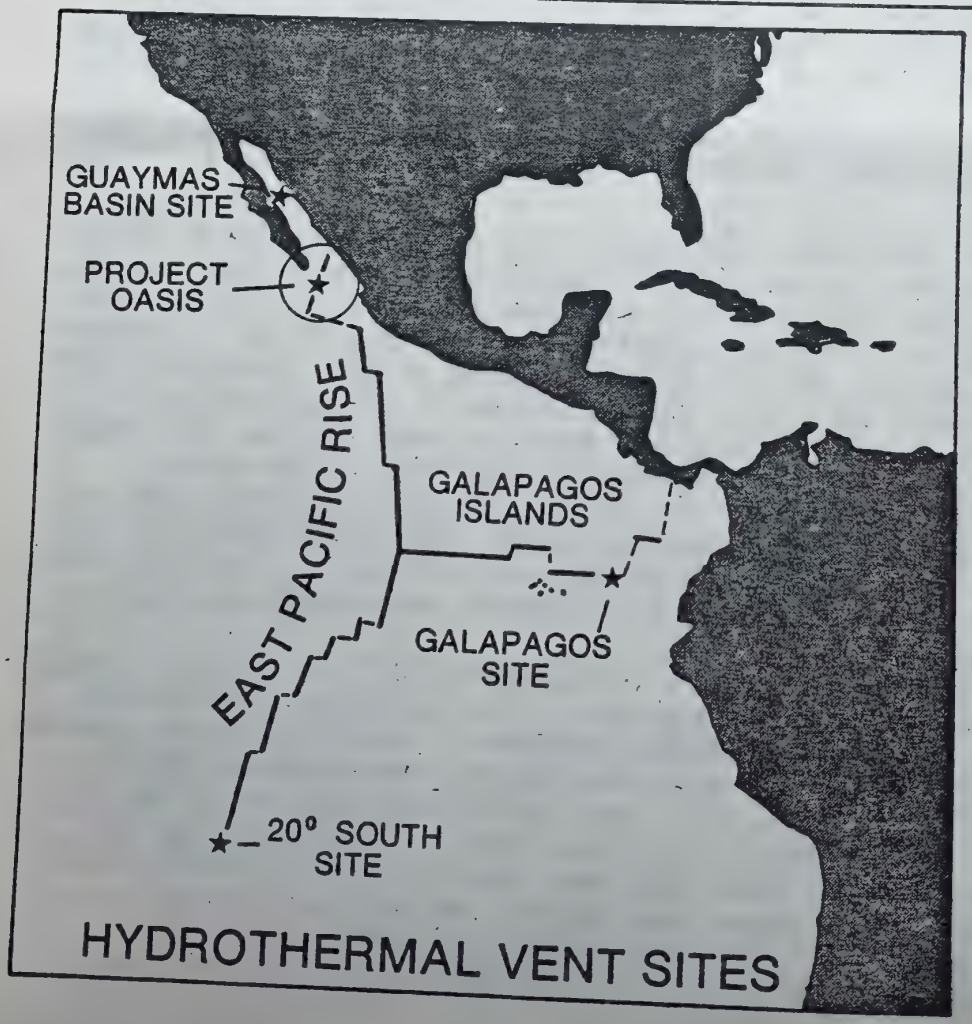
"I was piloting L V on a survey of the 16" well gas line from Shell Brent to Cormorant a distance of 6 K. Dive #234, water depth 480', on 6-28-81. The unit was in a poor condition laying by the side (N) of the pipe. I was moving easterly on the south side at the time I saw it. I advised surface and due to the nature of the survey, did not stop as I knew I could cover it when I returned surveying the north side. This I eventually did.

"I carried out a full survey of the device using color video and taking 35 mm color photographs. When L V was recovered and back on board her support ship BRITISH VOYAGER, I was then made aware of the full significance of the discovery. During my submergence Shell London had been notified and subsequently had contacted the Royal Navy, who in turn dispatched a team of people to identify and dispose of the unit. Well, to cut the story short the mine was identified as being dangerous and subsequently recovered from the seabed and placed on the stern deck of the VOYAGER under a constant deluge of water from fire hoses. We were then on passage to Berwick in the Shetland Islands where the mine was lowered back into the water with a demolition charge and finally destroyed."



Scripps Institution of Oceanography

Graphic of the 16-ton submersible Alvin, which, from a depth of 8,500 feet, explored the sea floor about 150 miles south of the tip of Baja California.



Hydrothermal Vent Research Grows

In an expedition late last year to undersea hydrothermal vents at 21° N. Lat., 120 miles off the tip of Baja California, scientists for the first time captured white fish that had been observed earlier.

One fish, 30.5 cm long, was discovered trapped in a hatch area of the submersible *Alvin*. On another dive two were caught in a similar way. Researchers aboard the research vessel *Melville* froze the fish for later laboratory analysis ashore at the Scripps Institution of Oceanography.

Another first for the National Science Foundation-funded expedition was the collection of hydrothermal vent fluids undiluted by sea water. They were collected in specially designed titanium bottles at temperatures up to 349° C.

A large expedition to conduct biological studies of the vent communities was scheduled for this month and next month. Both the 74.6 m *Melville*, the *Alvin* and its tender *Lulu* are again being used for these operations.

A Journey Into Inner Space

Scientists Probe Mystery Of Life Around Deep-Sea Hot-Water Vents

First of two articles

On April 13, an international contingent of researchers left San Diego to study unique marine communities surrounding deep-sea hot-water vents 150 miles off the southern tip of Baja California. Staff writer Warren Froelich joined the mission while at sea, observing the scientists at work for nine days.

By WARREN FROELICH
Staff Writer, The San Diego Union

There was no countdown. Though the dawning sky was tinged in gray and the sea was cresting in small caps of white, a midmorning launch still looked possible.

Final preparations were under way as the service crew went through its checklist. The tiny craft's intricate lighting and camera systems were tested. A robot-like mechanical arm was put through its paces. Valves were tightened, ropes knotted, wire neatly wound. Traps and containers to carry back strange life forms were fixed in place.

Scientists Robert R. Hessler and Carl Berg looked after their experimental equipment. Hessler, from the Scripps Institution of Oceanography in La Jolla, was paying special attention to his sophisticated stereo camera and meter-long temperature probe. Berg, from the Marine Biology Laboratory in Woods Hole, Mass., was making sure his laboratory-concocted trap was functioning. Bob Brown, the pilot, kept his eye on the crew.

Two more hours of this passed. The ship, a 16-ton submersible called the Alvin, was just about ready. It was time for the scientists to start thinking about the next eight or nine hours, to get themselves physically and mentally prepared for their journey into inner space.

Hessler, tall and lanky, placed small bandages just below his elbows so he could lean against the hard metallic surface without bruising himself. To get a good view through Alvin's three pineapple-sized portholes, he would have to contort his body into positions it didn't like.

He was a jogger, not a gymnast, he said.

"It's hard for someone as stiff as I am," complained Hessler, 49, thinking about the cramped 7-foot-diameter sphere he would soon inhabit with two other persons.

Berg, decrying the classical stereo tapes on board, brought with him two other cassettes better suited to his tastes — one of country singer Emmylou Harris, the other with soft-rock recordings from a San Diego radio show. He also would need some warm clothes, he said.

"It's 62 degrees in there, damp — and you're kneeling or crouching all the time," he explained.

As the last crew members signed the checklist, Hessler and Berg stood by. The Alvin's mother ship, a catamaran called the Lulu, rocked spasmodically on the waves.

Metallic gratings that allowed the crew to work around the Alvin were removed. The small vessel, still resting on an elevator, was gently lowered into the sea. The elevator motor whirred. As Alvin nestled between Lulu's pontoons the pilot, followed by Hessler and Berg, walked a gangplank and climbed down inside through a hatch at the top of the vessel.

Slowly, with two swimmers along to collect an external telephone and holding lines, the Alvin moved away, its red top bobbing a few hundred feet from the Lulu.

Then, a few minutes later, it disappeared. One swimmer held a telephone receiver above water while the other swam to a whaler waiting nearby.

Soon, Hessler and Berg would be surrounded by darkness. They would sink for more than an hour, protected from the acute pressure and near-freezing temperatures by their titanium-lined home. They were at a site 150 miles south of the tip of Baja California, along an area of sea floor called the East Pacific Rise, 8,500 feet beneath the water's surface.

Here, they would explore a section of a newly discovered biological community where, until recently, no life was thought possible. They would find an exotic mixture of long red tube worms, giant clams, crabs and an odd assortment of snails and fish thriving on a food chain linked to a sulfide-consuming bacteria.

It was a scientist's dream to be part of this discovery and to explore its frontiers. Berg and Hessler knew that.

"I always wanted to be a hero," Hessler kidded. "At least my mother said I should be."

* * *

The world's deep seabeds, for the most part, ironically are not unlike a desert. Instead of a shortage of water, however, these deserts suffer from a lack of food.

Acute pressure, upwards of 250 times that of sea level, and near-freezing temperatures make an inhospitable environment for life.

Even more crucial, little light can penetrate much beyond 100 yards of water. This is important, since green plants require energy in the form of sunlight to make food for themselves and other organisms to live. All known life on this planet was thought to be supported by plants and photosynthesis.

That is, until scientists came upon so-called hydrothermal vent communities. Instead of relying on green plants, a unique life system seemed to build around previously unknown bacteria that converted hydrogen sulfide into food for a variety of strange animals.

In some cases it appeared these chemosynthetic bacteria grew inside the animals in a classic symbiotic relationship — without need for sunlight to sustain life.

It was a mind-boggling revelation.

"It was probably the most significant biological, oceanographic discovery in a little over a hundred years," said Dr. Kenneth Smith, a research biologist at Scripps and program coordinator of the East Pacific Rise vent expedition, appropriately dubbed "Oasis."

Geologists had long been speculated that deep-sea hot water springs existed along huge plates that, like giant jigsaw puzzle pieces, join to make up the Earth's crust. It therefore was a group of geologists who, in 1977, were the first to find vent communities 300 kilometers east of the Galapagos Islands.

On subsequent missions, teams of scientists located similar colonies at other such sites. One was in the Guaymas basin of the Gulf of California, one was near Easter Island on the East Pacific Rise, and yet another was found 270 miles off the coast of Oregon, the first in U.S. coastal waters.

Best known of all the discoveries however, was the one at a site 21 degrees north on the East Pacific Rise, the Oasis site. As molten rock swells up, two large plates here gradually separate, at roughly 6 centimeters (2½ inches) a year — as fast as a fingernail grows.

About 25 vents have been mapped at the site, roughly 5 miles long and a fifth of a mile wide. Water spewing from these regions range anywhere from a warm 20 degrees Centigrade — forming stalagmite-like columns up to 100 feet tall called "white smokers" — to superheated sulfide chimneys called "black smokers," where temperatures exceed 350 degrees C.

To date, most vent missions had been ones of major discovery — revelations of new and spectacular life forms thriving in what previously had been considered hostile environments. But "Oasis" was to be different, a chance to answer questions about the life cycles of these communities, to fill in the biological blanks.

Some of those questions include:

— How did these creatures migrate to the vent sites, what their larvae look like, whether they travel on currents — and, if so, did they swim by themselves or hitch a ride?

— How fast do these creatures grow, and what are the best conditions for that growth?

— How hydrogen sulfide, consumed by bacteria, is converted to animal tissue, and how fast do these animals metabolize this food?

— How long does it take for a vent community to evolve and die?

"The exciting thing in this field is that it's in the forefront of science," said Dr. Holger Jannasch of the Woods Hole Oceanographic Institution. "That's the attraction of the whole thing. That's why so many biologists want to be a part of it."

"Oasis," set up to answer many of these questions, indeed was popular.

The mission, funded with a $1.7 million grant from the National Science Foundation, attracted 40 scientists from 21 institutions in the United States, Mexico and France — the largest mission of its type.

Four vessels made up a floating research armada — the Melville, a 244-foot research vessel operated by Scripps; the New Horizon, a smaller Scripps vessel that would be used for radioactive isotope work; the catamaran Lulu, and the Alvin, both operated by Woods Hole.

Also on board were reporters, who were invited to help publicize vent research. The scientists believed this would help them obtain funds from a Congress looking for programs to trim.

"None of us think we're pulling the wool over people's eyes," Hessler said when asked about the reporters' participation in the mission. "We honestly believe this, and want the story told.

"Besides, the man on the street, when he runs across this stuff is interested in it; he enjoys it, it captures his imagination. This is a real gee whiz project, like the space program.

"Isn't it nice we can give them something back?"

* * *

Douglas Nelson, a young Woods Hole researcher, knows about the Alvin — its history, how it works and its importance to oceanographic research.

He also knows that sometimes it can malfunction — like on his first dive ever, while sitting 8,500 feet under the water's surface at 21 degrees north on the East Pacific Rise.

"I was too ignorant to be scared," he said.

To be sure, the Alvin is the technological centerpiece of many of today's major oceanographic missions. The submersible, housing a 7-foot pressurized titanium sphere, has made more than 1,200 dives to depths of more than a mile since its birth in 1964.

Recently, the Alvin has averaged about 100 dives a year. But this pace has been stepped up even further with increasing numbers of expeditions. Twenty more dives were expected to be added during the Oasis mission.

As a result, a certain amount of fatigue began to set in. Nothing major, but minor problems such as faulty valves, worn-out springs and leaky sealants were starting to test Alvin's dedicated service crew.

"The sub is pretty tired," confirmed Ken Smith, mission coordinator. "It needs an overhaul."

Several hours of Oasis diving time were lost because of minor malfunctions. Each hour on the bottom costs an estimated $14,000. And months of scientific planning and experiments depend on samples collected, areas photographed and surveyed, and equipment put in place during those crucial dives.

Diving time is one of the key ingredients to a successful oceanographic mission. That and the weather.

So far the weather had been close to ideal.

It was the fifth dive that gave mission scientists their greatest worry — Doug Nelson's dive.

Traveling with a fellow Woods Hole scientist, Howard Sanders, the mission was set up to conduct several experiments — some from their own labs and a few for other researchers. A crab trap was to be deployed, clams moved away from their homes to other locations in the vent community, and equipment to test clam respiration was to be set up.

Everything started out as expected. Nelson and Sanders watched the crystal-blue waters of the Pacific quickly fade into an abysmal black as they sank into the sea at a rate of about 90 feet per minute.

Gradually, on their 90-minute plunge to the bottom, they could see a myriad of tiny bright flashes of luminescent underwater life through their portholes, as dazzling as a meteor shower.

As the vessel approached the bottom, they turned on the port lights and contacted the navigation room aboard the Lulu for further instructions.

They were about 90 meters from their appointed destination. Slowly, the Alvin revved up to its cruising speed, one knot. Then, all of a sudden, the difficulties started.

"What happened was we were virtually at the site and a bunch of trouble alarms went off," Nelson recalled. "They were ear-splitting. No way we could think with those things."

The alarms, per se, didn't frighten Nelson. But when Ralph Hollis, the Alvin's normally unflappable senior pilot, said "Oh, oh, we got trouble," Nelson said his heart began to pound a little faster.

Hollis contacted the Lulu and with the experts there tried to figure out what was going on. They couldn't. At first, Hollis said something about having "to go up right away," but then it was decided to do as much as they could without moving.

"At that point I was a little apprehensive," Nelson said. "But as long as I didn't see water coming in, I figured I was OK."

Actually, the alarms simply meant that the sub was losing hydraulic pressure. It still had power, but further movement could risk further and more time-consuming damage to the propulsion system. Even if propulsion were completely lost, the Alvin could drop a series of weights totaling 800 pounds and rise to the surface. That was standard procedure.

By midafternoon the Alvin did just that and returned to the surface. A few hours of mission time had been lost.

"It was really incredible," Nelson said the next morning. "I wish we had more opportunity to see what we going on. I wish we had more of a chance to explore a little more."

Sanders was more casual.

"Today was like any other dive, unusual," he would say later that evening.

Hessler, a veteran of two decades of oceanographic exploration, kidded: "You know, your hair wasn't white when you went down."

To which Sanders replied: "My friend, my hair turned white when I was in my 20s — and I wasn't scared then, either."

* * *

Three days later, it was Hessler's turn.

Minor problems continued to plague the Alvin. But the crew, sometimes working through the night, located and repaired the tired vessel. So Saturday's mission — that of Hessler and Berg — was expected to carry a full schedule of experiments to help make up for lost diving time.

Top priority was given to collecting live animals, particularly tube worms and clams.

While the scientists were attempting to complete their assigned tasks under the sea, the Lulu crew was busily scraping and painting the catamaran deck. Others passed the time getting a tan or swapping stories, principally with crew chief George "Brody" Broderson, whose white beard, balding head and tattoos lent an appearance similar to the cartoon character, Popeye. And the captain kept an "Alvin/Lulu" T-shirt concession.

Some who worked at night were asleep in cramped crew quarters located in the craft's pontoons.

Finally, as the horizon began to streak with orange and gray hues, the Alvin's red top popped above the waves.

A few minutes later, about nine hours after the dive began, Hessler and Berg were on board.

Berg's trap worked according to plan, he reported.

Hessler, on the other hand, said he was "bitterly disappointed" that the temperature probe on his camera malfunctioned.

Now the moment was at hand for splitting up the day's catch. The thick plastic lid was opened, hands reached in, and the division of booty began.

James Childress, a scientist from the University of California at Santa Barbara, had first pick, grabbing several healthy red tube worms and large clams for a variety of physiological experiments.

A giant white clam went to a scientist from the Marine Biology Laboratory in Woods Hole, Mass.; three-foot-long tube worms were given to a researcher from Scripps Institution of Oceanography in La Jolla. A strange-looking bristle worm went to a man studying animals in ocean sediment.

Soon a small white fish was removed, placed on a dissecting pan and divided for several scientists.

"We got a desperate problem," one scientist yelled to Robert R. Hessler, a researcher at the Scripps Institution. In his hand, the scientist held a small white crab.

"I'll take care of that," said Hessler, grabbing the creature. He walked away for a moment to figure out what to do with it. As chief scientist aboard the Melville, a 244-foot research vessel operated by Scripps, Hessler was in charge of distributing samples and arbitrating any disputes over specimens. When he came back, the crab had been opened, revealing two bean-sized parasites.

"We'll find someone who deserves this," he said. "Do you have any interest in this?" he asked a scientist from Cornell, "because there's a guy up at Scripps who would be."

Roberta Baldwin, a staff research associate at Scripps, wandered over with notebook in hand. Her job, for the moment, was to record the destination of each specimen, along with its description and the day and time it was caught. She marked down the crab and parasites for the Scripps scientist.

Off the Melville's stern, crew members had gathered for a post-dinner game of backgammon and a little night fishing. Rock music blared from a tape deck. Camera lights flashed.

Scientists continued to parcel out specimens for more than two hours. Some living samples were analyzed that night on board. Others were "pickled," placed in Formalin for future experimentation. Still other samples were placed in freezers located on the main deck.

Richard Lutz of Rutgers University in New Jersey was among the last to obtain samples, picking through a strainer holding tiny shrimp, limpets and worms. Lutz hoped he would find the larvae of a giant clam; so far, his search had been futile. But the young, bearded researcher remained enthusiastic.

"This is a chance of a lifetime to study a unique system," he said. "We're on the forefront of oceanography."

* * *

Indeed, hydrothermal vent communities — first discovered off the Galapagos Islands in 1977 — have captured the imagination of marine biologists throughout the world.

At these hot-water sites, dense communities of unusual animal life thrive where sunlight never penetrates. Here, abundant growths of bacteria serve as the base of a unique food chain, manufacturing food "chemosynthetically," using hydrogen sulfide concentrated around the vents.

So when Project Oasis was organized for the most intense investigation of one of these communities — at a site 21 degrees north of the equator, 150 miles south of the tip of Baja California — 40 scientists from 21 institutions in the United States, Mexico and France signed up.

The underwater workhorse of the five-week mission is the Alvin, a 16-ton, three-man submersible that can search the sea floor for specimens, stow them and bring them to the scientists above.

"This is a working cruise, where we fill in the details," said Woods Hole researcher Holger W. Jannesch. "It's too popular for our tastes, but the opportunity to go again was tremendous."

Added William "Bud" Smithey, a technician at Scripps: "On most cruises you have maybe one, two or three PhD's. On this one, I haven't even counted them up yet."

Each investigator had a task to fulfill, a question or questions to answer.

Some were interested in the respiration and metabolism of the vent community animals. Others wanted to learn about the life cycles of these creatures, how they were born and how quickly they grew.

Some wanted to find out how these creatures moved from one vent site to another. Others wanted to know how long these sites lasted.

Some wanted to learn more about the behavior and appearance of the larger animals. Others were more interested in the smaller creatures and microscopic organisms flourishing at the site.

Cooperation would be required to help answer these questions. Competition for samples and dive time would be inevitable.

Egos occasionally would clash. And there were few diversions. Mealtime would be the great social event of the day, that and tanning or jogging on the ship's bow, dubbed "steel beach."

Kenneth Smith, a research biologist at Scripps and program coordinator for Project Oasis, acknowledged that a mission of this size would be unlikely in the future.

"It's just too big for one person to handle," he said. "None of us are administrators; we're scientists. We're not in it for the money, but the love of it.

"No one else is going to be willing to administer a program like this again."

* * *

For Jim Childress, time was the enemy.

Unlike many of the scientists on board, the Santa Barbara researcher had to work with live samples. Any delay could be critical.

So once specimens were brought on board after dusk, his lab went into action, sometimes working till 3 or 4 a.m. before quitting.

"We have as much or more invested in terms of level of effort and money as anyone," he said flatly.

Indeed, Childress wasn't afraid to let someone know if he felt his rights were not being respected.

"People I'm mad at, know I'm mad at them," he acknowledged during a quiet moment one day. "I tend to have a high profile. My usual tendency is to be off on my own more."

Because Childress was getting plenty of samples to work with on this mission, confrontations thus far had been minimal and his lab was kept busy.

Alissa Arp, one of his assistants from Pasadena, analyzed the blood content of the large tube worms. The worms have no mouth, gut or anus. But they do have a large organ called a trophosome, filled with sulfide-consuming bacteria.

One thing the Childress group wanted to find out was if this sulfide was carried by the blood — and if so, how much.

By the end of the first week, they had an answer. They also had another question.

"The blood can carry large amounts of hydrogen sulfide," Childress said, "larger than would normally be considered toxic. How can it do this? We don't know yet.

"We're just fishing in the dark."

Childress also is measuring the metabolism of these animals, keeping them alive under varying pressures. Normally, deep-sea animals have low metabolic rates, consistent with their energy-limited surroundings.

But the vent animals seem to be displaying a metabolic rate not unlike shallow-water creatures, Childress said.

Scripps scientist George Somero confirmed this seemingly rapid metabolism in his lab, using radioactive carbon as a tracer.

But one thing he still can't figure out is why enzymes responsible for certain metabolic pathways are not altered by the vent's intense pressure, temperature extremes and normally poisonous sulfides.

Somero believes that somehow these enzymes become adapted to their harsh surroundings. But so far he has no answers.

"We're scratching our heads to see how these enzymes work," he said. "The animals must have some protective system.

"It's like putting mussels into a gas chamber at San Quentin — except the animals here survive. We don't understand how."

As the blood sulfide content and enzyme mysteries illustrate, vent research seems to be yielding more questions than answers. Some observations seem to be defying accepted biological laws — such as one that says boiling water kills all living creatures.

Since their discovery Holger Jannesch, a microbiologist and veteran of oceanographic research, has been interested in the various types of bacteria growing in the vent communities. It was Jannesch who, during a research mission to Galapagos in February 1979, proved that bacteria there thrived on hydrogen sulfide energy.

With Project Oasis, he would study nitrogen-fixing bacteria and microorganisms that seemed to be consuming methane.

He also was interested in finding bacteria that seemed to thrive at temperatures higher than 100-degrees Celsius — a concept that would boggle the mind of any biologist.

Late last year, marine biologist John Baross of Oregon State University said he found such bacteria at the 21-degree north site living at the tops of vent chimneys. Normally, life at those temperatures — greater than the boiling point of water — would be considered impossible, Baross said. The only explanation, he added, must be high pressures that actually prevent boiling.

Jannesch wants to confirm Baross' work, even though it will only lead to others such as, why isn't the bacteria protein destroyed by the heat?

"We were always taught that the boiling point would kill everything," Jannesch said. "This work shows we have to get rid of these limits in our thinking. You never know if something is foolish until you disprove it."

* * *

For Jannesch and a few others, there may be a practical application for all this — some day.

Jannesch already has begun a series of tests at Woods Hole to explore the food-producing potential of sulfur-digesting bacteria. In these tests, bacteria are fed a seawater cocktail containing hydrogen sulfide and ammonia.

The bacteria use this mixture to manufacture carbohydrates needed to sustain life. These sulfide-nourished bacteria are, in turn, fed to shellfish such as mussels, who cleanse themselves by discharging a harmless sulfate residue back into the sea.

Michael Kleinschmidt, an amateur diver from Los Angeles, believes a similar system could be used to cultivate black abalone in shallow-water vent sites near San Pedro, Calif.

Jannesch envisions a day when industrial sulfide wastes could be used to feed his bacteria.

"I think it's more practical to use hydrogen sulfide waste than natural hydrogen sulfide seen in vents," he said.

Richard Lutz, who works for the Rutgers University Department of Oyster Culture, hopes that a better understanding of how vent organisms develop and why they grow so rapidly may one day help produce larger and faster-growing shellfish.

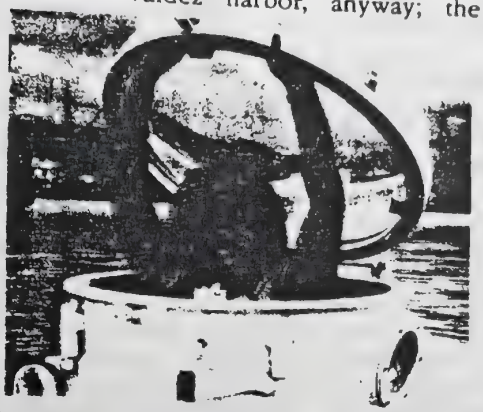
"If we could start understanding why we see rapid growth rates, understand something about nutrition down there," he said, "we could potentially apply these to commercially important species.

"Maybe we could answer some questions about how we can utilize a chemosynthetic system. Can we enhance growth? Can we build a bigger and better clam?

"Those questions are far removed from the ones we're asking now. But you build from individual blocks. You never know what may lead from a blind alley to a commercial product."

Yellow (almost) submarine

It's a sporty little two-seater with a yellow-and-white paint job, and it gets a lot of attention around Valdez, Alaska. Around Valdez harbor, anyway; the "two-seater" is a subcompact submarine owned by Sohioan Jan St. Pierre and her husband Real.



Battery-powered motors propel the sub. Faucet-handle controls make the craft dive and surface—maneuvers which can be tricky, says Jan, administrative assistant for Sohio at the port of Valdez, near the trans-Alaska pipeline terminal. "We've hit bottom kind of hard a few times and bobbed up to the surface faster than we'd like."

The sub is fun to take out for a dive, but it was bought for business. Real, a professional diver, repairs tankers for Sohio and other companies. He takes the sub down in the frigid Alaska waters to inspect hulls of the big ships which load up Alaska oil at the terminal.

Diving Unlimited International (DUI) has introduced the warmest diver underwear available. This new underwear is 2X warmer than any other diver underwear and is not affected by moisture or water. Since the material is non-compressible, there is neither buoyancy nor insulation change with increased depth, therefore, lead weight is necessary. The underwear is washable and can be dried in a household dryer.

The material is constructed in three layers. A rugged water-repellent nylon on the outside with a low friction surface allows the diver to easily don and take off his drysuit. Inside is the miracle material Thinsulate® Insulation Type-M manufactured by 3M which is low bulk, lightweight and thin. The third layer next to the skin is also water-repellent nylon. The one-eighth inch compressed thickness of this new underwear has the thermal protection of two "Wooly Bears" currently used by some divers today.

DUI and the U.S. Navy have spent four years testing this new concept for diver thermal protection. It is currently being used in the Antarctic and being tested in France and the North Sea.

New Sub for Norwegian Operators

Norwegian underwater contractors Tromso Underwater Services has ordered the new remotely operated vehicle (ROV) Super Dart from International Submarine Engineering of Canada.

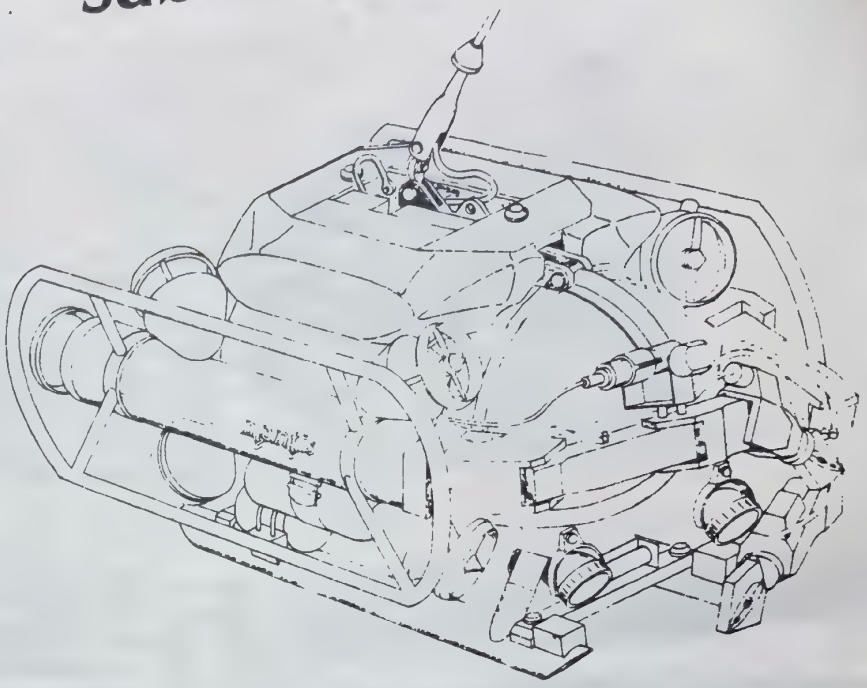
The Super Dart system, the first to be ordered by a Norwegian operator was due to enter service last month, and incorporates four hydraulically-driven thrusters, developing 75 pounds static thrust each, a multi-function manipulator, microprocessor control, auto depth and heading systems and a range of inspection/navigation cameras.

The order for the new ROV system which will be deployed via a specially designed winch and garage handling system currently under contruction in Tromso, supplements a recent order for I.S.E.'s Hy Sub ROV system placed by sister company Bergen Underwater Services.

))) **WASP Diving Suit to be Used off Santa Barbara.** WASP, the one-person submersible or one atmosphere diving suit, take your pick, will be used extensively in the 550 meter deep Santa Barbara Basin 10 miles off central California next August and September. It will operate from the 52 meter research vessel *New Horizon* of the Scripps Institution of Oceanography. Aim of the expedition, during which WASP will make three to four hour dives several times a day, is to observe and collect animals that are ordinarily too elusive or too fragile to capture in traditional nets, study the complex luminescent systems some animals use to signal each other, and investigate the daily up and down migrations of the animals of that depth. To capture gelatinous specimens a device nicknamed a "slurp gun", a tube 6.35 cm in diameter will suck in the animals without damaging them as a net would. It is being designed by Graham Hawkes who designed the WASP. Funded by the National Science Foundation, the project is to be headed by Dr. Bruce H. Robinson, and Dr. Alice L. Alldredge, an assistant professor of biology, both of the University of California, Santa Barbara.

MANTIS: A New Approach To Deep Subsea Working

by Graham Hawkes
Technical Director
OSEL Offshore Systems Group
and Designer of the Mantis



It has been said that the subsea engineering industry is at an equivalent point in its development to that of the aircraft industry 20 or 30 years ago. It is now some 20 years since the Triest, with Jacques Piccard and Don Walsh on board, descended to the greatest known ocean depth, the Marianna Trench at 11 000 m. The Triest lingered for some 20 minutes and then returned to the surface.

Today we are at the beginning of a new generation of ocean technology. The pioneering days are over and need is for safe and reliable equipment that can be used day after day in all kinds of weather. Currently, most subsea work is in support of the offshore oil industry, bu the future will bring additional demands in terms of mining, the winning of food, and ocean management.

The classic way for man to work underwater is for him to turn himself into an aquatic mammal. He stores the air he needs to breathe in compressed form in a cylinder on his back, and transmits it to his lungs by a demand valve which automatically supplies air in equilibrium to his surroundings.

The surface-demand diving techniques developed for the commercial offshore oilfields work well and easily, but only to a depth of some 50 m. Beyond that depth, and as divers need to go into saturation, the escalation in equipment size and cost becomes excessive. However, saturation diving is carried out successfully and relatively safely down to depths of approximately 360 m.

Conventional Submersibles

Beyond this depth the other traditional method of working is to use what can be described as conventional submersibles. These are quite large vehicles, usually with a crew of two or three, that operate from a dedicated mother ship. However, all subsea work methods must be viewed in terms of economy as a total system, and the need for a mother vessel makes it very expensive to employ a submersible. This has led to the virtual demise of this method of subsea operation.

The Mantis, developed and marketed by OSEL Offshore Systems, is a new approach to the problem of deep subsea working. It is not a conventional submersible since it is tethered to the surface by an armoured-steel umbilical cable in much the same way as a diver, and it is so small that it does not need a dedicated mother ship. But neither is it a conventional diving system because the operator is in a shirt-sleeve environment, at normal temperature and pressure. He breathes air, which eliminates the physiological and physicological problems of deep ocean diving.

The Mantis, in fact, is an engineering alternative to a deep diving suit. It is a minimum-size machine, and it was designed to meet several requirements.

In the first place, it must protect its pilot within a pressure hull from the pressure and other physiological problems associated with deep diving. Secondly, its thrusters and propulsion systems must give the operator the ability to move at will in three dimensions in mid-water.

The third requirement, which presents a challenge because it is apparently in conflict with the first, is that the pilot must be in sensory contact with his workpiece, and must be able to interface with it and perform work upon it. Hence the Mantis is equipped with large external manipulators that substitute for a diver's own arms and hands. Various sub-systems complete the vehicle, and they include lights, still cameras, closed-circuit video cameras, a range of navigational instrumentation, various specialized tools for making and breaking hydraulic connections underwater, hydraulic cable cutters and brushes, and various rotating tools for inspection and cleaning.

A critical part of the system is the tethering cable, and it has several functions. Firstly, it is a mechanical cable and it is used to lower and recover the vehicle from the water. This is a significant safety feature and the first line of defense is that, if anything goes wrong, the vehicle and its occupant are simply plucked from the water in the same way that a fisherman would wind in a fish on a

hook. The cable also serves to reduce the size of the vehicle by providing the power from the surface, and it provides a primary communications and data link between the pilot and the surface.

However, should the cable become snagged or in any way interfere with the Mantis's operation, the pilot can cut it free from his vehicle. On doing so, emergency batteries automatically provide power for all systems and a back-up means of communication, using modulated high-frequency sound through water.

Tethering Cable

The Mantis is a one-man, tethered micro-submersible, and the pilot breathes recycled air at atmospheric pressure. Electrical power for all services is normally drawn from a surface supply unit by means of the tethering cable, which also provides hard-line speech communication and video channels to the surface. The cable is armoured and is used in conjunction with a dedicated winch on the surface to directly launch and recover the vehicle. The normal operating attitude is with the pressure hull horizontal and the pilot lying on a contoured couch, but he has sufficient freedom of movement to be able to turn on to his back. The forward end of the submersible is an optically-clear acrylic hemisphere, which gives the pilot a panoramic view.

The vehicle and manipulator controls are carried on a projection of the couch to the acrylic hemisphere. Switches and controls that are needed only occasionally—together with life support systems and instrumentation—are fitted into an overhead unit which runs the length of the hull above the pilot. The aft dome hinges open for access. Two jettisonable side pods are fitted to the pressure hull, and each carries five thrusters, power transformers, electrical power control modules, manipulator mounts, a buoyancy tank and compressed air systems. The jettisonable emergency batteries and skids, together with the trim weights, are fitted beneath the pressure hull.

The main component of the pressure hull is a simple, filament-wound glass-reinforced plastic cylinder of approximately 650 mm internal diameter and a wall thickness of about 50 mm. At each end, aluminum LM25 TS casting plugs with O-ring seals are seated into the bore of the cylinder. The whole assembly, consisting of the front acrylic hemisphere, the two aluminum end rings and the cast aluminum entry dome, is clamped together by an external frame work of tie-bars.

"Silent Design"

A poorly designed pressure hull, when subject to pressure, will emit noises that to the pilot seem deafening and terrifying. This is caused by components with different rates of contraction moving against one another. This explains the very careful "silent" design of the Mantis, which enables all parts to float unrestrained and leaves the pilot oblivious of the forces being resisted by the hull.

The power drawn from the cable is fed into two transformers—one in each pod. The input is normally 415V and the ouput from the transformers 30 V RMS. A 30-V operational level for the submersible was chosen, despite the high currents involved, to ensure the safety of divers who might work close to the submersible. The 30-V power rail is rectified in each pod and supplied to the thrusters, lights and so on by power relays mounted outside the pressure hull.

A current-limited 30-V line is taken from each pod into the pressure hull for internal services for carbon dioxide scrubber motors and control, and for further-refined power supplies to instrumentation and the like. In addition, a current-limited 24-V line is brought from each of the emergency battery pods into the hull. Thus in the hull there are four sources of power, each current-limited and protected by a magnetic circuit breaker, and any one will provide sufficient power for all normal operations.

Eight Main Thrusters

There are eight main thrusters, with four fitted to the port side and four to the starboard, and angled so that combinations will provide full maneuvering fitted, primarily to provide an independent propulsion system for safety reasons. The control circuits are again duplicated, and the pilot's primary control is either a joystick or a push-button control, which are interchangeable and are used as the pilot prefers. A secondary-emergency control station is provided, and it is a dual-circuit line with independent connectors, power supplies and so on.

Thus the Mantis has full redundancy on all propulsion-system functions. This is necessary because the vehicle is designed to enter such structures as oil rigs, where in an emergency it is not possible simply to blow tanks or drop weights and surface under the forces of buoyancy. Once it has entered a structure, the Mantis must be able to leave by precisely the same route.

The air pressure within the hull is maintained with 400 Pa of atmospheric pressure. Two electrically-powered carbon dioxide scrubbers are fitted. Each has a duration of about 40 hours and if necessary can be used manually with a face-mask. Two automatic oxygen make-up systems are fitted and each has a duration of approximately 40 hours. The high-pressure oxygen is regulated down to about 400 kPa and then is bled automatically into the atmosphere to maintain the reference pressure at approximately 105 kPa.

Audible Warning

The pilot has a partial pressure of oxygen readout and a very sensitive gauge shows cabin pressure changes. The submersible is also fitted with an independent pressure monitoring system which gives an audible warning to the pilot and to the surface of high-pressure or low-pressure conditions. Both of the oxygen systems have high-pressure shut-off valves and the flow can be adjusted manually, overriding the automatic operation. Oxygen flow meters are also provided.

The rear access dome is sprung-loaded closed, but will crack open a limited amount to relieve high internal-pressure approximately 5 kPa above ambient. The dome is used for pressure venting or to prevent large forces building up on hinges and catches, and a very quick response in relieving large volumes if necessary.

Two separate buoyancy systems are fitted, with one to each side pod. Various modes of operation are possible, but essentially the systems are quite separate. They are gas-blown water tanks operating at ambient pressure, but the physical arrangement of the vents allow the

tanks to be fully flooded prior to launching.

Each system has its own compressed-air store and associated contents gauge and instrumentation, and is operated by two mechanical breakthroughs in the forward aluminum hull ring. The first operates the air-blow valve and the second the air-vent valve. In normal operation, the air-blow valve will be crossed-linked, allowing one air store to blow both tanks simultaneously and keeping the other store in reserve.

Operated By Sea Water

The two manipulators fitted to the front of the vehicle are hydraulic in the true sense of the word, in that they are operated by sea water. The energy source is an electrically drive sea-water pump, and this unit, together with its associated valves, is housed in the pods, with one for each manipulator.

The manipulators are machined from a nylon chosen for its low intake of water and dimension stability, and because its specific gravity is very close to that of sea water. The result is very ragged manipulators which, instead of being tucked in to prevent them from being damaged, are usually held out as fenders and used to shield the rest of the submersible. Yet despite their massive strength and resilience, they are close to being neutrally buoyant in water.

Ten Mantis vehicles have been completed and more are under construction. The depth-rating for manned operations has been increased to 700 m but, OSEL is working on much deeper systems and a whole new generation of manipulators. These it is hoped, will vastly increase the work capability. The group's aim is to develop the concept until the Mantis can replace the diver in all work tasks and at any depth.

Acrylic Submersible Viewports

Acrylic viewports and conning towers utilizing Transpalite® S; flat viewports up to 36" diameter by 8" thick, hemispherical viewports up to 56" diameter by 8" thick, and conning towers up to 48" diameter by 8" thick—all rated to depths of 5,000 feet. Stanley Plastics (Developments) Ltd.

Lockheed Receives Order For DSRV Low-Pressure Life Support System

Lockheed of San Diego, Calif., announced recently it had received a U.S. Navy contract to design and build a self-contained, low pressure life-support system for one of the two Deep Submergence Rescue Vehicles (DSRV).

The potassium superoxide (KO_2) life support system is designed to absorb carbon dioxide exhaled by the DSRV's 28 occupants and automatically to release oxygen into the submersible's atmosphere.

The KO_2 system will replace a complex, high-pressure pure oxygen system that presently is carried onboard in tanks.

The year-long contract is the result of a successful test of a prototype life support system built in 1981. It was derived from a system that Lockheed designed, built, and installed and successfully demonstrated on its own Deep Quest research submersible.

Yi-Sheng Li, project manager of the KO_2 system for Lockheed Missiles & Space Co., said a single canister about half the size of an office wastebasket contains enough potassium superoxide to supply oxygen and control carbon dioxide for about 15 man-hours. The DSRV's three pressure spheres normally will carry 32 canisters, giving an endurance of 480 man-hours.

Mr. Li said there will be two KO_2 systems when the DSRV installation is complete: the regular system which will release oxygen directly into the DSRV atmosphere, and an emergency system which will provide oxygen to each occupant through face masks in case the disabled submarine interior is contaminated.

Each emergency system canister will supply five crew members for about three hours. The standard canister will be interchangeable between the regular and emergency systems.

Since 1970 Lockheed has conducted research and development on KO_2 life support systems. A one-hour self-rescue breathing apparatus was certified in the mid-1970s by the U.S. Bureau of Mines and the National Institute for Occupational Safety and Health (NIOSH). An emergency breathing system for an undersea oil capsule later was certified by the American Bureau of Shipping. Also, the life support system for the Lockheed Deep Quest research submersible was certified by the firm's Senior Safety Board.

In 1980, using the KO_2 system, the Deep Quest with three crew members established a record for small submersibles in total time submerged.

Mr. Li said the DSRV system has been improved over that tested on the Deep Quest. The system is simpler in construction, control, operation, and maintenance for increased reliability and safety.

Lockheed designed, built and delivered the two San Diego-based DSRVs to the Navy in 1970 and 1971. Designed to dive to 5,000 feet, they can rescue up to 24 trapped crewmen per trip from fleet submarines stranded on the ocean floor. Each is operated by a crew of four.

Joint Venture To Market Modified Version Of Saab-Sub

Scandinavian Underwater Technology (SUTEC), the Swedish concern which last year took over the remotely-operated tethered Saab-Sub submersible from Saab, has now teamed with the submarine expert Kockums to form a joint venture to develop a new version of the underwater work vehicle, now renamed *Sea Dog*.

The project is being undertaken under the name Sub-Craft AB. SUTEC is supplying the technical expertise for continued development of the Saab-Sub. Kockums is underwriting the financing. The aim is to modify and perfect the vehicle to perform a variety of underwater work tasks with high accuracy and flexibility.

Sub-Craft now has a prototype *Sea Dog* on order from SUTEC for delivery in November, 1982.

))) **ROV Performs Science Mission.** What is believed to be the only remotely operated vehicle (ROV) dedicated to in-ocean science work recently made geological observations of shallow relief structures. Harbor Branch Foundation's CORD II (Cabled Observation and Rescue Device), operating off Fort Pierce, Florida, Feb. 8 and 9, in two dives made more than seven hours of videotape of the structures and the predominance of living coral related to them. On the first day CORD was lowered to a depth of 73 meters and the structures were surveyed over an area of about one-third of a square mile for 4 hours, 25 minutes. The second day's dive lasted five minutes longer and covered an area 2.5 miles long, fulfilling the same objectives. Geologist for the mission was Dr. Charles M. Hoskin. . . . .CORD II is a second-generation ROV equipped with: two lights; sonar; four thrusters; low light TV with pan, tilt and focus; six-function manipulator; hydraulically operated collection basket; and a Hasselblad camera system and stroboscopic flash. Power supply to the vehicle is 500 VAC, three phase. Signals are sent to the operating van aboard the research vessel *Sea Diver* indicating hydraulic pressure, oil temperature, water temperature, water speed, depth and compass heading. All signals to and from the vechicle are computer-multiplexed and sent though a single 1 centimeter triaxial conductor cable. Nine more missions are planned for 1982.

))) **Semisubmersible Sinking Triggers Investigations.** When the $120 million American-owned semisubmersible drilling rig *Ocean Ranger* sank during a storm Feb. 14 in the Hibernia Field off Newfoundland, it took 84 men to their deaths. Strangely, two other smaller rigs nearby survived. Radio transmissions heard by the other rigs indicated that a ballast control room port had broken and the sea poured in, shorting the electrical system. Three weeks later the rig was located by Can-Dive Services, Ltd., a joint venture partner of Oceaneering International working under contract to Mobil Oil Co., using the Perry Recon-J remotely operated submersible carrying the Honeywell 902 acoustic locating and positioning system. Currently the U.S. Coast Guard has convened a board of investigation, and a Canadian commission is active.

Divers find sunken rig 'upside-down'

ST. JOHN'S, Newfoundland (UPI) — Divers have located and filmed the wreck of the sunken oil rig Ocean Ranger, which is lying "upside-down" on the ocean floor, a Mobil Oil Canada spokesman said Thursay.

"Divers have observed and videotaped" the wreckage of the rig, using mini-submarines, Mobil spokesman Mel Pine said.

The Ranger, the largest semi-submersible drilling platform in the world, toppled over and sank in 95-knot winds and 20-meter (65 feet) waves on Feb. 15. All 84 men aboard the rig were killed, and only 22 bodies were recovered.

The rig was drilling an exploratory oil well, about 170 nautical miles southeast of St. John's, for a consortium operated by Mobil.

The wreckage was located by the scientific ship Polaris V, equipped with side-scan sonar and other sophisticated electronic gear. The visual observation and photography of the sunken rig was conducted from a Mantis mini-submarine that operated from a second vessel, the Balder Cabot.

Pine said "although the data is sketchy and inconclusive, we have determined that the rig is upside down on the ocean floor."

The wreckage was in "about 265 feet of water" and was located 100 meters east of the wellhead where the Ranger actually sank, he said.

The Balder Cabot, returned to St. John's late Wednesday. The Polaris was expected to return later Thursday.

Pine would refused to comment on whether the rig was intact or whether more work would be done at the site of the wreck.

He said "all data gathered" was being handed over to government authorities, who are still organizing what was expected to be a lengthy inquiry into the tragedy.

TAG is a compact, self-contained system specifically designed for use with underwater work vehicles. As part of an operating vehicle system, **TAG** can be used to mark, locate, and recover objects beneath the ocean surface. When **TAG**'s vehicle self-rescue feature is activated, **TAG** serves as an emergency locating and retrieval device, which both marks the vehicle's position underwater and reestablishes a critical link between the submerged vehicle and the surface.

OBJECT MARKING

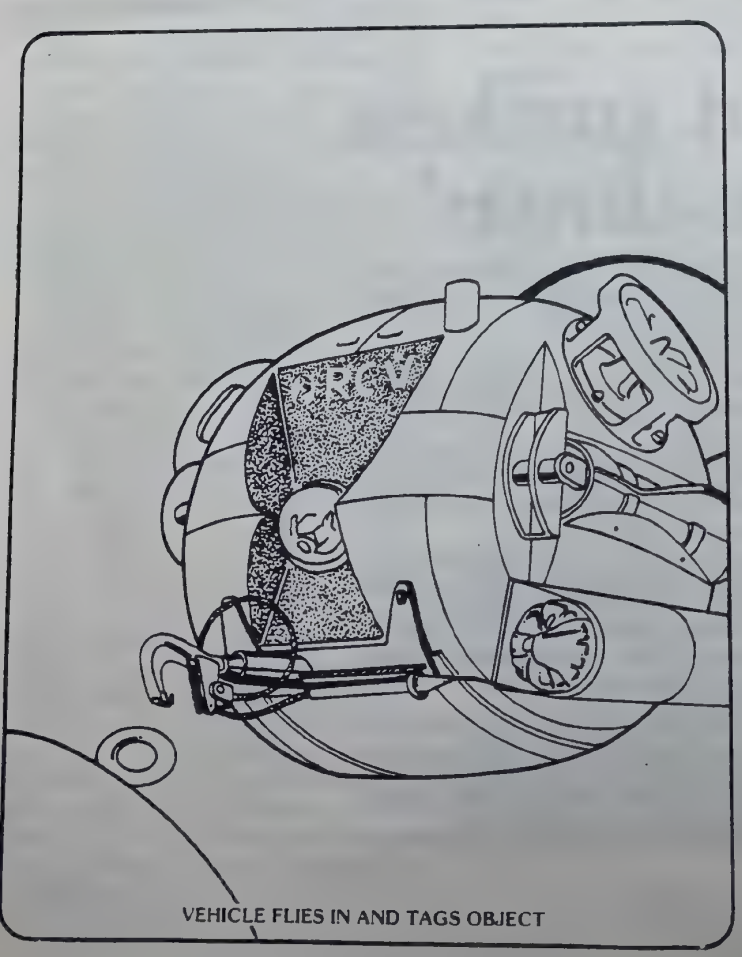
- Speeds process for locating submerged objects
- Eliminates the need for repetitive and costly searches
- Provides flexibility in determining when and how to work an underwater site

SUBMERGED OBJECT RETRIEVAL

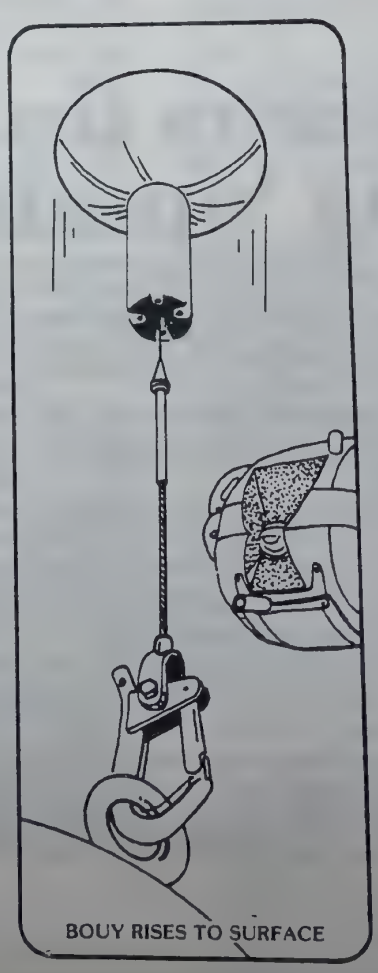
- Reduces the amount of time and expense involved in underwater recovery operations
- Eliminates the need for complicated procedures and costly retrieval equipment

VEHICLE SELF-RESCUE

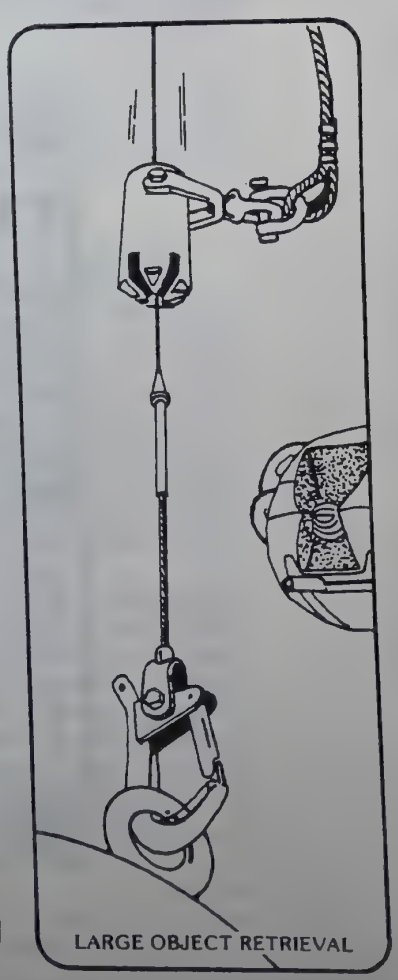
- Acts as a safeguard against the costly possibility of vehicle loss
- Reduces the amount of downtime spent in conducting a search



VEHICLE FLIES IN AND TAGS OBJECT



BOUY RISES TO SURFACE



LARGE OBJECT RETRIEVAL

TAG
SYSTEM DESCRIPTION

Hydroscan's **TAG** system is designed for ease in field installation and operation, and is configured for use with any remotely-operated vehicle currently working in the world's oceans. **TAG's** unique **MOUNTING BRACKET ASSEMBLY** with **ATTACHMENT-AND-RECOVERY HOOK** bolts easily into place on the vehicle's frame. Two trim, free-flooding cannisters also readily mount to the vehicle. An inflatable yellow **BUOY** with 1200 feet of spooled, 0.1-inch diameter **KEVLAR LINE** is packaged in one cannister. The other cannister houses **TAG's ACTIVATION MECHANISM,** including a Battery Pack and Electronics Package, a Bottle of Compressed Air, and a small Pyrotechnic. **TAG's WEIGHTED MESSENGER** assembly is retained at the surface and attached separately, after the **BUOY** has risen, to the 1200-foot **KEVLAR LINE,** for purposes of large object retrieval.

As designed, Hydroscan's **TAG** system features a unique versatility in performing a variety of underwater work tasks. The Attachment-and -Recovery Hook ratchets 360 degrees to aid in ease of placement by the vehicle. Once the hook is locked onto an object, it automatically releases from the vehicle. The surface operator then triggers **TAG's** Activation Mechanism which jettisons the inflatable Buoy and 1200-foot Kevlar Line. This completes **OBJECT MARKING,** and the vehicle is free to leave the site and perform other work tasks. If the marked object weighs up to 500 pounds, **SMALL OBJECT RETRIEVAL** is possible simply by pulling in the Kevlar Line attaching object to Buoy. **LARGE OBJECT RETRIEVAL** (for objects weighing up to 2500 pounds) is possible when using the Weighted Messenger with a surface vessel lift line attached: the Weighted Messenger slides over the **TAG** line and travels down to the Attachment-and-Recovery Hook where it locks into place; the marked object is then hauled to the surface by reeling in the surface vessel lift line. **VEHICLE SELF-RESCUE** entails triggering **TAG's** Activation Mechanism; in this case, the yellow Buoy marks the vehicle instead of an object, and may also be used for vehicle recovery.

TAG comes complete with spares, and all ancillary equipment and tools necessary for system operation and maintenance. Optional **TAG** system configurations for varying operating depths and increased lifting capabilities are available.

SYSTEM SPECIFICATIONS

Maximum Operating Depth:	1000 feet
Weight (on vehicle in water):	9.5 pounds
Lifting Capacity (using only TAG line):	500 pounds (3 times factor of safety)
Lifting Capacity (using weighted messenger and lift line):	2500 pounds (4 times factor of safety)
Line Capacity:	1200 feet
Air Bottle Pressure:	3000 pounds/square inch
Switch Requirement to Operate System:	less than 100 milliamps
Materials of Construction:	17-4H900 stainless steel 6061-T6 aluminum and delrin
Buoyancy of Lift Bag:	35 pounds at surface
Tag Line Construction:	.089-inch Kevlar with .010-inch polyurethane jacket

CHRIS LANDRUM

HYDROSCAN 9373 ACTIVITY ROAD, SUITE D, SAN DIEGO, CALIFORNIA 92126

DSPA MEMBERSHIP LIST CHANGES AND ADDITIONS---JULY, 1982

ANDRUS, Leslie E.(Ensign, USN)
(DSV-3 TURTLE)

RES: 6585 Bullock Drive
San Diego, CA 92114
(714)479-9169
BUS: DSV-3 TURTLE
Bldg 497, NAS, North Island
San Diego, CA 92135
(714) 437-5612

de FROBERVILLE, Gerard C.
(Capitaine de Fregate (R)
(ex-ARCHIMEDE, GRIFFON,
SHELF DIVER)

RES: BP 1997, Papeete, Tahiti
Polynesie Francaise
( )39496
BUS: Chef de Service du Plan de
L'Industrie et L'Artisanat,
Directeur du Bureau de Developpe-
ment, Conseiller Scientifique et
Technique du Conseil de Gouverne-
ment de Polynesie Francaise
BP 2900 Papeete, Tahiti
( ) 20175

DE WEESE, Craig A.
(ex- NEKTON)

RES: 7846 E. Woodsboro Ave.
Anaheim, CA 92807
(714) 970- 1044
BUS: K-Jack Engineering Co., Inc.
1522 W. 134-th St.
Gardena, CA 90249
(213) 327-8389

FLAHERTY, Gerald M.
(ex-PISCES VI)

BUS: change IUC to Oceaneering
(indirect information)

GOLDSBY, William
(ex-PISCES VI, SEA LINK)

RES: Rt. #1 (Fairfield Mountains)
Lake Lure, NC 28746
(704) 625-9414
BUS: Oceaneering International
Advanced Systems Group
Houston, TX

JOHNSON, Philip E., (Capt. USN
(ex-DEEP JEEP) Ret.)

RES: 6534 Colonade circle,
Pensacola, FL 32506
( )
BUS:
( )

NEWELL, James Kirk (Cdr.,USNR)

RES: no change

SCHILTZ, John A.
(ex-SEA CLIFF, TURTLE)

RES: 2660 Mission Blvd, #8
San Diego, CA 92109
(714) 286-4990
BUS: Honeywell Marine Systems Operations
9620 Ridgehaven Court, #B
San Diego, CA 92123
(714) 571-0514

SMITH, David John
(PISCES-3, 8)

RES: 55 West Park
Carnock, Fife, Scotland
(0383) 850827
BUS: HMB Subworks, Ltd.
Boundary Rd.,
Harfreys Industrial Estate
Great Yarmouth, Norfolk, England
( )

WORTHINGTON, Robert K.R.
(Capt., USN, Ret.)
(ex-DEEP QUEST)

RES: 754 Buck Avenue
Vacaville, CA 95688
(707) 447-7235
BUS: (same)

ED Note: (1) Apologies to Brad Mooney and Olivier Bouet-Willaumez. At press time, I find that their address information is in the material that I left with Don Saner to turn over to the new DSPA Secretary.
(2) No current addresses are available from McClay, McKinney, or Cameron. Shame on them!

MarineTechnologySociety-San Diego

Can you believe it? Next March our active San Diego Section will host an international conference and exposition focused on remotely operated vehicles and relating technologies. We've now taken the idea and, under Bob Wernli's guidance (he has been selected as Conference Chairman), we've come up with a name, theme, location and dates.

ROV '83 is the conference name. Simple and direct. Lets you know exactly on what the conference will focus.

Theme is also appropriate: "A Technology Whose Time Has Come." How true. That couldn't have been said too many years ago because it was still struggling for acceptance in the offshore marketplace. Ask any ROV marketing manager.

The location is good. Holiday Inn at the Embarcadero. The management there, I'm told, is anxious to work with us and will strive to give our conference and guests first class service. Convenient to the airport and the many attractions of our beautiful city and surrounding areas.

We've got some good dates, too. March 14-17, 1983. That's in-between the International Diving Conference in New Orleans (February) and the Offshore Technology Conference in Houston (May). It doesn't conflict with the Easter holiday break, fits in well with offshore oil-patch work schedules and provides outsiders an excellent window to get away from Old Man Winter's last, brutal gasp.

So we're off and running with ROV '83. We even have a logo designed by our good friend, Joe McChesney of The Advertising Works. This will appear on our Call For Papers just getting ready now, conference stationery, advertisements and posters.

What more do we need? Your help. Many Section members have volunteered for the various committees that work to put on a show of this sort. Yet we need your support, encouragement and advice. Talk it up with your friends and colleagues. Spread the word so that ROV '83 truly will be an international meeting of those working and vitally interested in this growing technology of subsea robotics.

Deam Given, Editor

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

OCTOBER, 1982

Vol. XV, No. 3, Published by the Deep Submersible Pilots Ass'n

The Deep Submersible Pilots Association was formed in 1967 to provide for a free interchange of information relative to deep submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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Editor, DSPA
754 Buck Avenue
Vacaville, CA 95688
(707) 447-7235

or

Donald E. Saner
President, DSPA
4707 Berwick Drive
San Diego, CA 92117
(714) 278- 4613

Correspondence regarding new member applications should be addressed to:

Willis Forman
Membership Chairman & Vice President, DSPA
1527 Linwood Street, Apt. 5
San Diego, CA 92103
(714) 295- 0620

EDITORIAL NOTES AND COMMENTS

For the first time since departing San Diego in June, your Editor returned for the regular monthly meeting. It was held, as usual, at Tarantino's. Attendancewas swollen to a total of thirty Members and guests due to having John Pritzlaff of Westinghouse Oceanics as guest speaker. John kept us all intrigued with an account of his recent travels in Japan and China, both as a tourist and as a guest of the governments. Discussions of the deep submersible programs of both nations were ,of course, of primary interest; but his observations ranged over the shipbuilding industry, solar power research, and other fields as well. A description of the simulator for training crews of the SHINKAI 2000 made us all envious.

The Treasurer has reported an abnormally large number of Members have been derelict in payment of 1982 dues. Perhaps part of the blame falls on the Staff for not sending formal billings. Please remember that we have no secretarial assistance and do all work on our own time. We need the cooperation and assistance of all hands. For myself, I admit feeling a much greater impetus to get to desk to produce a Newsletter when I receive a volume of letters and data for copy from you men in the field. So, let us hear from you. Remember, if you are temporarily at large, the DSPA will carry you as needed until you are again employed.

John Schiltz has assumed the duties of DSPA Secretary on an interim basis pending the upcoming elections. In case you have misplaced your address list, make a note of this:

Honeywell Marine Systems Operations
9620 Ridgehaven Court, #B
San Diego, CA 92123

SECRETARY'S REPORTS AND NOTICES

Elections- It is essential that all hands return their marked ballots immediately upon receipt.

Addresses- Again , we plead with you to advise us promptly when your address changes, whether residence or business.

DSPA Dues in arrears, as of the last word from the Treasurer, constitute a real drag on the DSPA treasury.The lengthy list of Members who have neglected to pay the nominal dues for 1982 (U.S.$10.00 for USA and Canada addresses and U.S.$15.00 for overseas addresses)is as follows:

Jim Barker	Bill Leonard	Larry Shumaker
Rich Boggs	Mike Macdonald	Al Smith
Vance Bradley	Doug McKinney	Mike Staehle
John Cameron	Ty Merritt	Robert Taylor
Frank Chambers	Dick Otter	Joe Thompson
John Dryfka	Kevin Parker	Ray Toler
Fres Haag	Doug Privitt	Pete Traphagen
Jim Helle	Gary Rees	Jim Vernon
Ralph Hollis	Don Rosencrantz	Mel Wills
Chris Landrum	Ross Saxon	Merle Wilson

This is the final notice to the above named Members. Please pay your 1983 dues at the same time. Payment may be submitted to any DSPA officer, preferably to the Secretary of Treasurer.

DSPA Luncheons have been held monthly in San Diego. Richard Tackabery of Ametek-Straza was the guest speaker on 9/15/82, and John Pritzlaff of Westinghouse Oceanics spoke on 10/28/82. The next meeting will be on 11/18/82 with Tom Vetter of NEKTON, Inc. speaking. No meeting is planned to be held in December.

Membership Cards- It has been the practice to forward new cards with the next Newsletter to be mailed after receipt of dues payment. If you received an '82 card or have a cancelled check to indicate that the above list is in error, please advise the DSPA Secretary or Treasurer.

International Conference on Underwater Operations and Techniques will be held 6-8 December at Paris, France. Chairman is Pierre Willm, c/o A.T.M.A., 47 Rue de Monceau, 75008 Paris, France. Busby, Galerne, and Vadus are on the Program Committee.

CALL FOR PAPERS

OCEANS '83

MTS-IEEE
CONFERENCE
& EXPOSITION

Oceans '83 P.O. Box 70970 Sunnyvale, California 94086

"EFFECTIVE USE OF THE SEA—AN UPDATE"

CALL FOR PAPERS The Marine Technology Society (MTS) and the Institute of Electrical and Electronic Engineers (IEEE) Council on Oceanic Engineering (COE) invite papers from all interested authors for the OCEANS '83 Conference and Exposition. Each accepted paper will be presented by the author(s) at the conference in San Francisco, California, which will be held at the Hilton Hotel, 29 August through 1 September 1983. All accepted papers will be published in the Proceedings and mailed to the participants at the conclusion of the conference.

The theme of OCEANS '83 is "Effective Use of the Sea—An Update". This theme serves to underscore the objectives of marine science and technology to explore, conquer, develop, and utilize ocean resources for the benefit of all mankind. The goal of the conference will be to identify the current and future technology, knowledge, and programs needed to achieve these objectives by the year 2000.

Papers are requested which:

- Highlight technological advances in the understanding, use, and recovery of marine resources.
- Identify/suggest other technologies that could be used to advance marine science and engineering.

OCEANS '83 will be international in scope and will focus on the science and technology required for the utilization of five major ocean resource areas: MINERAL RESOURCES and ENERGY, NON-MINERAL RESOURCES, TRANSPORTATION, OCEAN SCIENCE, and MILITARY OCEAN ENGINEERING. The emphasis in each of these areas will be on critical technologies, technology assessment, application, and programs. Papers that address other important developments applicable to marine science and technology will also receive consideration.

BACKGROUND Controversy arose in 1965 concerning the adequacy of our national effort to explore, understand, and develop the ocean. The President's Scientific Advisory Committee (PSAC) formed a Panel on Oceanography in May 1965 to address this controversy. In June 1966 the PSAC report, titled after their proposed national objective "Effective Use of the Sea", was issued.

After extensive hearings, Congress enacted the Marine Resource and Engineering Development Act of 1966. This Act expressed the conviction that serious and systematic attention should be given to the marine environment. It took steps to stimulate marine exploration, science, technology, and financial investment on an augmented scale. The Act also established a Commission, which became known as the Stratton Commission after its chairman, J. A. Stratton. This Commission examined the nation's need for development, utilization, and preservation of the marine environment. It also reviewed contemplated marine activities to assess their adequacy to achieve the national goal. The Commission report, entitled "Our Nation and the Sea, A Plan for National Action", was issued in 1969.

During this same period, the National Academy of Engineering was asked to assist and advise various government activities with their marine programs. The Academy formed an advisory committee, the Committee on Ocean Engineering (which later became the Marine Board), to carry out these tasks. The Committee, and later the Board, undertook a study of ocean technology, and what would be required to fulfill the national goals established by the PSAC and Commission reports. The results of this study were released in a Marine Board report in 1972 entitled, "Towards Fulfillment of a National Commitment".

Much has happened in the ocean affairs arena in the decade since these reports were issued. The goals of the OCEANS '83 technical program are to evaluate the progress towards achieving the objectives of these historic reports, assess the present state of technology, and describe programs that will make "Effective Use of the Sea" by the year 2000.

DEADLINE.....11 February 1983

NEWS FROM MEMBERS

Joe Vadus--NOAA (9/28/82)
"-----letter which should have been sent six months ago---(2/24/82)-I am most appreciative to DSPA for sending complimentary copies of the DSPA Newslatter. Thank you and Don Saner and the officers and members of DSPA for putting together a most informative and interesting newsletter. - For your information, I have appointed Roger Cook, of the Harbor Branch Foundation, as Chairman of the MTSUndersea Vehicle Committee. I note that he is not on yoyr roster of members but should be as a pilot of Sealink Submersibles.- There are several OCEANS conferences shaping up that you should be aware of since each will include sessions on undersea vehicles:

OCEANS 82 - Washington,D.C., September, 1982
OCEANS 83 - San Francisco, August, 1983
OCEANS 84 - Washington, D.C.
OCEANS 85 - San Diego, CA

Also, you should be aware of the International Conference on Underwater Operations and Techniques in Paris, December 6-8, 1982. Once again, thank you for keeping me posted. It is an honor to be listed among such accomplished and notable pilots in your mailing list."

Alan Whitfield--International U/W Pilots Ass'n (5/29/82)
"Please find enclosed enclosed the April Newsletter from the IUPA. Also a cheque for L8 to pay for my 1982 DSPA membership.- No major news to give you. I am off to Norway tomorrow, where MANTIS oo4 is still on contract to Norske Shell on the drilling rig Borgney Dolphin. Diving depth 1100 feet.
(Ed Note: Alan's mailing took two months to reach California.)

SCANNINGS. APRIL 1982

1.Simon Roddy is with ARMS.1. (Glomar Atlantic) diving to 1700ft in the Santa Barbara channel.

2.The Solus crew with the Perry DMB,off Australia,includes B.Masson,F.Rae,T.Pado, and L.Laverty.

3.During the latter part of 1981,the activities of B.O.L. were as follows. aug.- oct. PC1203 on charter to Subtec in Zadco Field.(Video survey).L3.and L5. on charter to Shell.(Voyager.)

nov. LR2 on manip trials for O.S.O.(Loch Linhe.).PC1802 and L5 on dry transfer trials for Royal Navy.PC1601 and PiscesII. survey for manganese nodules,Messina.

4.At the end of last year Barry Randle carried out the inspection of the largest SBM offshore,in the Cadloa Field,Philippines.Using Trec 10.on board the Smit Manila.

SCANNINGS - JULY 1982

1. The drillship Pelerin reports an interesting incident. This month the MOB 1000 on Board (operated by Hydrospace) was rescued from 600ft. offshore Newfoundland, Canada. During launch the lift line parted at 30ft., and the bell fell to the seabed. An H.M.B. Subwork, Mantis from the Balder Cabot was called in to perform the rescue, pilot K. Parker, Supervisor, C. Williams.

2. Tim Maudsley is piloting the MDU on Tharos (Sub contracted from S.S.O.). Ken Brumby who was with 2W (RCV 225) on the Stena Seaspread, is now supervisor on the M.S. RONGOS (Scorpio) for S.S.S. Survey of the Magnus to Brent 20 inch gasline. Tony Webb is in Australia (Perth) as a supervisor for Video Systems (RCV 150). Bob Humpston has been with Scotsub on the Mermaid IV trials and an ROV contract. R. Barr. K. Reynolds, D. Fairburn, S. Baker are on the Rig Western Pacesetter offshore Spain. (2X Mantis).

3. Magnus Jacket. B. Randle was supervisor on Scorpio 21 during the tow-out from Nigg Bay and the up-ending at the Magnus Field. Seven dives were carried out during the up-ending when difficulties were encountered with the piles. British Enterprise 5 (Consub II) Roger Chapman on board, and British Voyager with Martin Bulley were invloved. Various survey tasks were also undertaken, with the following personnel involved: B. Randle, D. Edmonds, T. Archer, R. Barnard, D. Charles, all of S.S.O.L. Pat Chilton operating RCV 225's for Santa Fe was on board the Balder, contracted to Hereema during piling.

4. J.P. Asknes reports that his company is now operating 2 X Darts (1200 ft. + 3000 ft. systems). A Hysub will be delivered this month for trials in Bergen during August. Next year two D.P. survey ships will be obtained.

SUBMERSIBLE NEWS AND VIEWS

from IRENE FAGER

Ian Dempster writes that he is still with British Oceanics Limited and things are now looking up for that once troubled company. To quote him: "The Company is now on an even keel and it looks like we are back into a profitable operation. This year we landed the largest ever underwater vehicle inspection contract awarded by Shell U.K. and worth over three million pounds. We are operating the BRITISH VOYAGER equipped with LR2 and LR3. The contract has been very successful and we can boast only 1.13% breakdown over 5 months. The work covers inspection of concrete and steel jackets, pipelines, and bottom surveys. Two of the more interesting tasks were the pre and post lay survey of the manifold system for CORMORANT A and the hull inspection of a tanker moored at a loading buoy." Thanks for the info, Ian. We're happy that B.O.L. is solvent again.

Now perhaps with the crisis over they will be amenable to doing covers for us once again. Send 2 covers, with 19½p British stamps, to...Mr. Ian Dempster, British Oceanics Limited, East Old Dock, Leith, Edinburgh, SCOTLAND. EH6 6PH.

Welcome back to SDL-1. They are diving again out of HMCS CORMORANT Halifax, N.S.--TURTLE will be making an extended deployment to the Hawaiian area.--A new ALVIN pilot has been qualified, Shaun Nerolich. ALVIN will also be piloted soon by a borrowed Navy pilot from SUBDEVGRU ONE.-- PISCES IV is diving again, pilots John Oszust, Frank Chambers, and Bob Taylor.-- Alan Whitfield has had two K-350 subs in his submarine school, and apparently he is going to sell one of them to a German group. -- John Dryfka and Mike Staehle have joined Perry Oceanographic's Program Management Staff. Perry's PC-1805 Diver Lock-out Manned Submersible finished hydrostatic test and is in the outfitting stage."

Yellow submarine offered in 'as is' condition

BY DANNY GROTHAUS
Chronicle Staff

CLUTE — Who wants a yellow submarine? A yellow submarine? Yes, a yellow submarine.

There's one here for sale but the current owner won't guarantee that once submerged, it will resurface.

"As is" is the only condition of purchase, says Jack Maris, the business manager for Brazosport Community College.

The tiny, 17-year-old submersible, measuring a scant 13 feet long and only 3 feet wide, is dry-docked on campus where, Maris says, prospective buyers may make "visual inspections only."

Original literature on the American Submarine-600 offers a long list of potential applications ranging from salvage work and offshore drilling operations to military use.

"Maybe Argentina will bid on it," quipped Maris. "Actually, I have no idea what someone would want with a submarine, but we have no use for it anymore."

The only college in Texas which offers a two-year associate degree in oceanography acquired the submarine 10 years ago as a gift from the U.S. Department of the Interior, says Maris. The sub had been used by the Fish and Wildlife Division and by 1972 was declared excess inventory.

Since then the college has used the vessel strictly on land, in parades and at fairs, as a symbol of the school's oceanography curriculum. He says the school never had any intention of using the submarine in the water and he can't remember if it was seaworthy at the time it was donated.

"You'd never get me to go down in that thing," says Maris. He's quick to say that the college offers no guarantee that the vessel is operational or seaworthy.

The manufacturer's specifications for the two-person submarine describes a potential cruising speed of six knots, a working depth of 600 feet and a maximum operation time of 16 hours.

The 3,200 pound vessel is designed to run on a 12-volt battery pack. It's original sticker price was $8,000.

Attempts to contact the submarine's manufacturer, the American Submarine Co. of Chicago, were unsuccessful. The company apparently is no longer afloat. The only similar listings in the Chicago area, the Americana Submarine Co. and the Chicago Submarine Co., manufacture sandwiches.

The college began advertising for bids on the submarine last month in local papers. Bids will be accepted through May 24. Maris says he has received only one serious inquiry.

"Maybe we should have advertised in the Houston papers," says Maris. "But who in Houston would want a submarine?"

Two brothers plan to start underwater charter service with sub bought for $4,000

BY DANNY GROTHAUS
Chronicle Staff

A Dallas bar owner wanted to put it in a swimming pool at one of his clubs. And the owner of a Houston apartment locater service wanted to use it to promote his business. But two brothers, a Yellow Cab driver and a computer technician, are the ones who ended up with the yellow submarine.

The men were among a dozen folks who bid on the two-man submarine offered by the Brazosport Community College in Lake Jackson.

The high bidders who ended up purchasing the submarine are Steven Salley, 28, the cab driver from Tomball, and his brother, Arthur Salley, 26, of 1607 Club Creek Drive in Houston.

Steven Salley said it may need "a few months of work" before the two can begin taking any underwater fares.

But that doesn't bother him. "How often do you get a chance to own your own submarine?" he asked.

The submarine which the college offered for sale carried no guarantees that it would float, dive, surface or do any of the things submarines are noted for.

The college received the submarine from the U.S. Fish and Wildlife office as a donation 10 years ago after the vessel was declared surplus equipment. The 3,200-pound submarine was manufactured in the mid-1960s and was originally designed to cruise at a speed of six knots at depths as low as 600 feet. The 3-foot-wide submarine is powered by a 12-volt battery pack, but the college had never tested its seaworthiness. The vessel had been used only on dry land to promote the school's oceanography curriculum.

The college received 14 bids from people around the state offering to purchase the sub. The bids ranged from a low of $1 to the Salleys winning bid of $4,000.

The two brothers shared the cost of purchasing the submarine. They plan to share in the work involved in rebuilding the submarine.

Steven Salley, an amateur scuba diver, says he hopes to refit the sub and begin contracting for work in salvage and underwater observation.

"I don't have any real experience in rebuilding submarines," he says. "It will definitely be a learn-as-I-go process, but I'm hoping it won't take more than a couple of months before it's in the water."

He said his friends' reactions are divided between the envious and "those who think I've lost my mind."

Once word got out that the sub was for sale, about a dozen other folks decided they had to have it, too.

A Houston man, Richard D. Lubbers, 43, says he would have bid $5,000 if he had known what Salley was bidding. Lubbers, of 12808 St. Mary, owns an apartment locator service and says he planned to use the submarine in his company's promotions.

A director of a San Antonio computer firm was hoping to bring the yellow sub home for "dissection" — just to take it apart and see how it works.

Antonio Carlisle, 32, is building his own two-man submersible for both salvage work and recreation.

"I was interested in dissecting that sub to determine if it would be made operational and see how it compared to mine," he said.

A Dallas bar and restaurant owner, Tom Stephenson, 33, had his own ideas for the 13-foot submarine. "It would have looked nice in the pool I have at one of my clubs," he said.

Stephenson says he had kept decoy ducks in the restaurant's outdoor pool as conversation pieces, but they kept getting stolen by local patrons. "I figure the submarine would have been more permanent," he added.

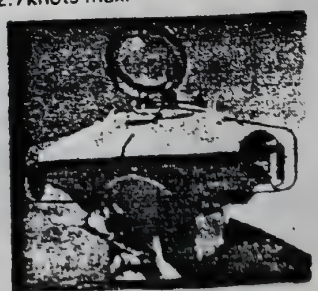
MARKASUB,
Gellerstrasse 53,
Postfach 206,
CH-4020 Basel,
Switzerland.
Tel: 061 423060. Telex: 63971.
Contact: Martin Kaspar.

The new miniature one-man submersible from Markasub — the *E2* — has been developed principally for survey and inspection of pipelines and structures. Its small size and light weight make it easily deployed and short training only is required of the operator.

Sophisticated systems have been avoided for the sake of safety and reliability but *E2* is capable of accepting a variety of tools and sensors.

Small size, ease of deployment, ease of operation, reliability and low cost running combined with versatility makes E2 ideal for many subsea inspection, repair and maintenance tasks in support of the offshore oil and gas industries.

Brief specs are: working depth 690ft; size — 1.85 x 1.83 x 1.4m; weight in air 630kg; speed 2.7knots max.



Sub getting new partner

By MICHAEL BOSTWICK
Staff Writer

WOODS HOLE — The relationship between the research submersible Alvin and the ship that carries it to its diving locations is so intimate that one Woods Hole scientist likens it to a marriage.

Early next year, the 25-foot-long Alvin will be divorcing its spouse of 16 years, the twin-hulled Lulu, and taking a new one, the Woods Hole Oceanographic Institution's 210-foot Atlantis II, which will be refurbished to accommodate its new partner's special needs.

The institution has recently received a $1.7 million grant to prepare the Atlantis II for the wedding, said George Grice, the institution's associate director for support of scientific operations. The three agencies providing the grant funds are the National Science Foundation, the National Oceanic and Atmospheric Administration and the Office of Naval Research.

The character of Alvin's launching and retrieval will change drastically, once it is linked with Atlantis II. Presently, Alvin is lowered into the sea on a cradle suspended between Lulu's twin hulls, Grice said. The principle is that of an elevator, with Alvin as the passenger riding into the sea.

For working with Atlantis II, Alvin will be fitted with a "single-point lift," analagous to a hook. Grice could not be more specific because institution engineers have not finished designing the device. An A-frame, also designed at the institution, will be built on Atlantis II's fantail. Alvin will be lowered off and hoisted from the stern of the ship on a 4-inch-thick nylon line that passes through the A-frame.

The $1.7 million will cover more than the cost of the hoist system's design and construction, Grice said. The grant also will pay for the construction of a hanger on Atlantis's deck. Alvin will be rolled on trolley tracks into the hanger so that its maintenance crew can work protected from the elements. To make room for the hangar, the ship's smokestack will be moved forward 10 to 20 feet.

In addition, Atlantis II will be fitted with a device called a bow thruster, Grice said. The ship's propeller, located in the vessel's stern, is turned off during Alvin's retrieval for fear that the tiny submersible could be sucked beneath the ship and damaged, he explained. The bow thruster is needed to safely provide the power and maneuverability to maintain the ship's position while its main source of power is temporarily off.

Finally, Alvin's support systems must be transferred from Lulu to Atlantis II.

Atlantis II has been docked at Woods Hole since last October for a "mid-life refit," an overhaul performed roughly halfway through the 30-to-35-year life of the ship, Grice said. The staterooms and laboratories aboard the ship are being upgraded and modernized, the engines, air-conditioning and ventilation systems are being refurbished, corroded plates on the decks are being replaced and the ship's superstructure is being sandblasted and repainted to rid it of a 19-year accumulation of rust.

Now that the funds are assured, the alterations to accommodate Alvin will be performed as part of the ship's midlife refit.

Alvin and Lulu left Friday to make a series of dives in the Bahamas, from which they are expected to return in December.

As part of its annual overhaul, scheduled for its return, Alvin will receive the single-point lift, Grice said. Alvin's conning tower also will be shortened so that the submersible will fit into its new hangar.

An exact date for the nuptials has not been set.

"Our target date for marrying Alvin to Atlantis II is next summer," Grice said.

The possibility also exists that the marriage could be annulled, if the couple fails to interact well during sea trials set for next summer.

"We plan for them to work around Woods Hole for a couple of months so that we can be sure the marriage will work and there won't be a divorce," Grice said.

Meanwhile, Lulu will likely remain in Woods Hole until connubial bliss for Alvin and Atlantis II is assured. Next fall, the institution will likely offer to return it to its owner, the Navy, Grice said.

Grice has high hopes for the Atlantis II-Alvin union. Atlantis II already has more scientific lab space than any other of the 15 vessels over 120 feet in the U.S. research fleet, he said. It's big enough that researchers not requiring Alvin's services will be able to carry out their investigations alongside the submersible operation.

The Atlantis II will be able to stay at sea longer than the Lulu. It is capable of traveling twice as fast as the Lulu, and will be able to launch the Alvin in rougher seas. The addition of the hangar will mean that the maintenance crew will no longer have to work on the exposed deck, as they must now aboard the Lulu, he said.

With Alvin aboard, "(Atlantis II) will be the most powerful ship in the (American research) fleet in terms of diversity of research programs it will be able to undertake," Grice said.

If all proceeds according to plans, he hopes that Atlantis II and Alvin will leave on their honeymoon in the form of an extended research cruise about Sept. 1.

Ed Bland sent the above info detailing the planned overhaul of ATLANTIS II. Also some news about present activities of ALVIN/LULU. The group was in transit to the Bahamas in October for 2 geology cruises and then transit to Virgin Islands about Nov. 3. Several trips are scheduled out of Frederiksted during Nov. including visits to their semi-permanent bottom station north of the island in deep water.(13,000')

OCT 82

Riviera Beach, Fl -- Perry Oceanographics, Inc. has delivered the PC-1805 manned submersible for charter in the North Sea by Shell/Esso. The four-man diver lock-out submersible is externally rated to 300m (984 FSW). The diver lock-out compartment is designed for internal pressurization to 200m (656 FSW).

The PC-1805 will be deployed from the multi-functional service vessel, STADIVE, now under construction in Finland and to be chartered by Shell/Esso, for underwater survey and pipeline maintenance work in the northern North Sea.

The vehicle is over 25 feet long, 8-1/2 feet high and weighs 16 tons (at neutral bouyancy). The normal bottom time is expected to be eight hours, which is reduced to four hours when the on-board survey equipment is in use. The PC-1805 is equipped with two six-function manipulator arms. Side scan sonar allows horizontal profiles of the bottom and other subsea objects which aid in pipeline tracking and plotting.

The PC-1805 communications system includes a VHF radio and underwater telephone system. A pinger transmitter allows tracking by a rescue vessel in emergency situations.

The vehicle is equipped with a sophisticated television system including a black and white low light level camera, two color cameras and two color monitors, as well as a 70mm still camera and strobe. During video recording, the control unit collects data such as heading, depth and echo sounder information and annotates the details onto the video monitor. The operator can input additional data from a portable keyboard.

The Perry PC-1805 is the fifth and largest in the PC-18 series.

New Underwater Vehicle From Hydro Operating For Santa Fe Diving

Santa Fe Diving Services, Inc., Houma, La., has announced that its first advanced-model, remote-controlled underwater vehicle, a Hydro Products RCV-150, has begun work off Brazil.

Thomas M. Angel, vice president and manager of the diving company, said recently that Santa Fe has a contract with Montreal Micoperi J.V. to provide the remotely controlled submersible vehicle and a crew of operators for the installation of the Enchova and Cherne platforms in the Campos Basin for Petrobras, the Brazilian government oil agency.

The RCV-150 was the first commercial unit produced by Hydro Products, and it is the fourth of 17 remote controlled submersible vehicles that Santa Fe intends buying. The three existing units are the smaller RCV-225 models. Santa Fe and Hydro Products are developing a winterized version of the RCV-150 for North Sea operations.

The RCV-150 is equipped with a low-light-level video camera, a high-resolution search sonar, and a multifunction manipulator arm that can grip, maneuver, saw, brush and cut objects in waters up to 2,000 feet deep.

The RCV-150 is housed in a submersible launcher that is lowered from a ship into the sea. Once submerged, the vehicle travels under its own power, remaining attached to the launcher by an umbilical tether cable.

An operator at the control console topside maneuvers the RCV-150 using a joy stick and steering with the aid of sonar, video pictures, compass, depth gauges and other instruments.

Santa Fe Diving Services, a subsidiary of Santa Fe International Corp., Alhambra, Calif., serves all phases of the worldwide offshore oil industry.

Scientists Find Mineral Deposit At Ocean Bottom East of Miami

Washington (UPI) — Scientists diving to the bottom of the mid-Atlantic Ocean in a small submarine in July discovered a massive mineral deposit that one researcher said looked "like a world of manganese" 10,000 feet deep.

A wealth of copper, zinc, silver and possibly some gold might lie beneath that manganese, according to Dr. Peter Rona of the National Oceanic and Atmospheric Administration (NOAA).

Manganese is a metal of great importance to the steel industry and Rona said the United States now relies on imports to fill its manganese needs. It is used in steel processing and as an alloy to toughen and harden steel without making it brittle.

NOAA, part of the Department of Commerce, reported the discovery Wednesday. It said the deposit is located 1,800 miles east of Miami, along the wall of a valley splitting a submerged volcanic mountain range running down the middle of the Atlantic.

Rona, chief scientist for the expedition, said the deposit is too deep to be mined with today's technology, but said: "It's an important resource for the future."

He said numerous deposits were found in an area two miles long and a mile wide.

A mechanical arm on the submarine retrieved pieces of the metallic deposit for study at the Woods Hole Oceanographic Institution in Massachusetts and the Massachusetts Institute of Technology.

Intersub buys new submersible

French submersible operator Intersub Services has commissioned a new three-man inspection vessel from Comex Industries, in Marseilles. For Intersub, the *OS 400-09* submersible represents a switch of manufacture from Perry. It should be delivered within 10 months.

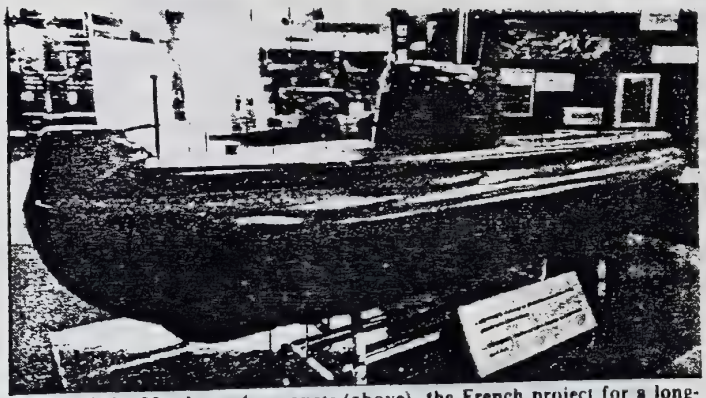
The new submersible will have a claimed speed of 3 knots from four auxiliary thrusters. Design features include two hydraulic manipulators, a 90cm panoramic viewport at the front, and nine viewports on the conning tower. Claimed payload is 400kg of equipment, and the vessel will be depth rated to 450m.

Bright outlook

At Comex Industries, the separate company which manufactures submersibles and heavy diving equipment for other commercial firms as well as Comex Services, the outlook appears promising, with new areas being opened up. For example 'we have already sold two submersibles to China', says sales executive Jacqueline Lamblot, 'and we have a technically demanding order for a diving system for the Far East'.

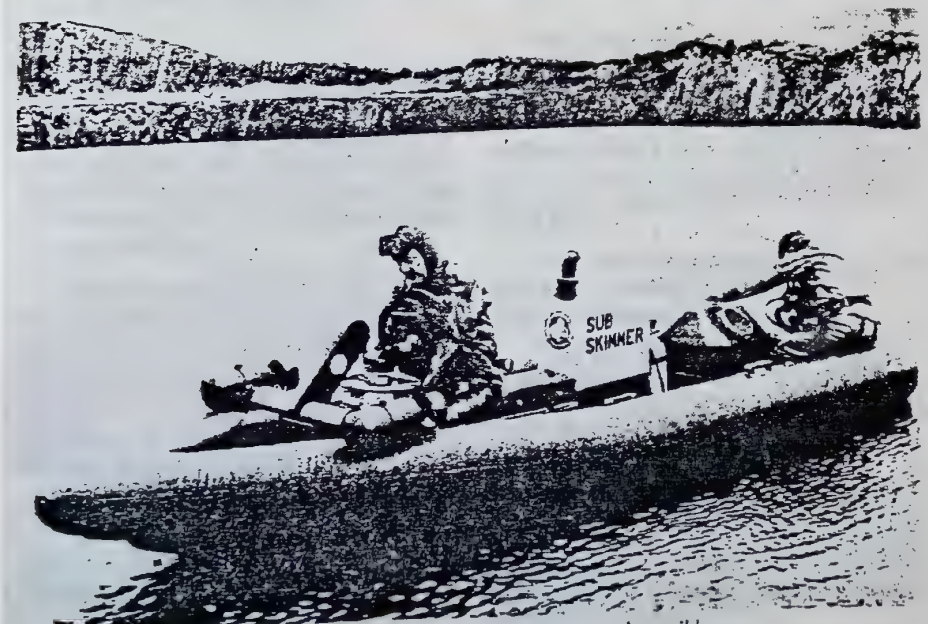
Comex Industries built its first observation submersible in 1976. Its first diver lock-out submersible was delivered two years after that and the company now has four such vehicles built or building.

For depths beyond 300m in technically advanced countries, the emphasis seems to be falling on rovs, says the company. Current contracts include three submersibles for the Soviet diving vessel being built by Finnish shipyard Wartsila — an observation and a lock-out submersible, and an rov. Systems for India and Norway are also being built, as is a 400m observation submersible for Intersub and two hyperbaric lifeboats for Comex Services.



Model of the 28m long *Argyronete* (above), the French project for a long-range submersible which Comex has decided to rescue after 10 years in mothballs (see *OE* April 1982). The submersible would carry 10 people, including four divers in saturation and able to lock-out at depths to 300m.

***Argyronete* had reached two-thirds completion when the project was suspended. The picture (right) shows the lock-out chambers, with main hull to the left and divers' chamber to the right.**



Subskimmer — a rigid inflatable that becomes a neutrally buoyant submersible

Comex Launches New Lock-Out Submersible

France's Comex Industries has launched a new lock-out submersible, the SM 360, that can conduct observation missions to a depth of 300 m. for site inspection, determining geographic locations, monitoring drilling operations and guiding re-entry.

The SM 360 can carry three workers and conduct atmospheric transfer operations on seabed production facilities. Divers operating from the SM 360 can carry out many of the tasks executed from a diving bell (one main advantage is that the lock-out sub can gain access to some subsea structures where a conventional diving bell cannot intervene). Comex will be seeking various types of contracts for the SM 360 including maintenance and control of subsea production facilities, pipeline surveys, clearing loads, cutting and releasing cables and fishing net, inspection of connections and rings of subsea equipment and control of trench profile to check the burial of pipe.

Wasp to be caged in rough seas

Extending the range of the WASP atmospheric diving suit into rough sea conditions is a concept under development at Oceaneering, Aberdeen. A garage (or Tethered Management Cage) is being developed for mid-water excursions.

Surface/sub-surface transport

ON OFFER for surface and sub-surface diver transportation in the air diving range is Subskimmer, a two-man rigid inflatable which will carry divers and their equipment and tools to a worksite at high speed, where the side bags are evacuated and the craft becomes a neutrally buoyant submersible with underwater control. Subskimmer can also recover loads of up to a ton to the surface by attaching the load to the under-hull and reflating the side bags. Tools are driven by compressed air.

The price of the Subskimmer system is about £50 000 with a six month delivery.
□ Contact: Submarine Products Ltd, Hexham, Northumberland NE46 4JP, UK, tel: 0434-604061, telex: 537510.

History will rise from the sea

By Ray Moseley
Chicago Tribune

PORTSMOUTH, England — On Sunday, July 19, 1545, King Henry VIII watched from Southsea Castle near here as his flagship, the Mary Rose, set sail to meet a French fleet in battle.

About a mile from shore the Mary Rose sank suddenly, inexplicably, in about 40 feet of water. Only about 36 of the 700 men aboard were saved. King Henry is said to have heard the cries of the drowning crewmen.

Today, if all goes well, the Mary Rose will be brought to the surface. Preserved in the fine silt of the sea channel off Portsmouth, the ship represents the most extensive record yet found of what life was like in Tudor England.

Archeologists also say she is the "missing link" between the Viking longboats and Lord Nelson's 18th-century wooden battleships. They say there has been no comparable discovery anywhere.

Already divers have recovered more than 17,000 artifacts from the ship, which will ultimately be displayed in a museum here.

Perhaps the prize find is a two-ton bronze cannon made in 1537. An inscription on it reads: "Robert and John Owen, bretheryn, born in the citie of London, sonnes of an English, made this bastard."

Archeologists say the term "bastard" apparently means it was not a standard make.

Until the Mary Rose was found, there was only one known Tudor arrow in existence. About 4,000 have been recovered from the wreck.

Divers have found the oldest English longbow in existence, a sea compass that may be the oldest in the world, and the earliest known piece of dated English domestic pewter, an exquisitely wrought wine flagon.

They found one gun made from a single sheet of welded iron, a technique never previously credited to the Tudors. Guns of that period were all thought to have been made of two sheets of iron held together by hoops.

Perhaps of greater interest to eventual museum visitors, the divers found a rich store of Tudor clothing, still carefully folded inside trunks.

They also found dominoes, gaming boards, combs, candlesticks, fishing tackle, a medical kit used by the ship's barber-surgeon and musical instruments.

The divers also found the butchered carcasses of venison, beef and mutton, fish bones, herbs, spices, peppercorns and fresh peas. When the ship went down, the cook was apparently preparing a meal of fish and mushed peas.

The skeletal remains of many crewmen were found, enough to enable scientists to determine their approximate ages. They estimate that 125 men were below the age of 18, another 125 were 18 to 25, 350 were between 25 and 35 and 100 were over 35.

The bones were reburied at sea, near the wreck, last year.

The Mary Rose was a 700-ton, 91-gun converted merchant ship. It was also the first ship to be fitted with complete gundecks.

Scientists say the silt that covered the Mary Rose preserved most of it from micro-organisms that could have destroyed it. The starboard side is well preserved but the port side, which was above the silt, has been eroded.

If the Mary Rose is not recovered today, it could be lost forever. High tides and winds are expected off Portsmouth after this weekend. If there should be any snag, the wreck, now dug out of the silt, would be destroyed by micro-organisms and sea erosion before a new salvage attempt could be made next year.

Ancient Ship Found Off Turkey

New York

A sunken Bronze Age ship that underwater archaeologists hope will prove to have the oldest intact hull yet discovered has been found off the coast of Turkey. The wreck is in 150 feet of water near the port of Kas.

From the shape of 50 copper ingots and four jars visible in the wreck, it is believed that the ship dates from about 1500 BC, which would make it the third oldest ship discovered. George Bass, director of the Institute of Nautical Archaeology at Texas A & M University in College Station, received word of the discovery by telephone Friday.

Bass said in a telephone interview that in neither of the two earlier finds was any of the hull structure preserved.

One, found by his group off Sheytan Deresi, Turkey, and believed to date from 1600 BC, consisted of widely scattered jars that had apparently been dumped when a ship capsized. The earliest remains, found by another group in the Greek islands, have been dated at 2500 BC.

It is believed that ships began plying the Mediterranean 10,000 years ago, before the domestication of animals.

The new find lies on the Mediterranean floor between Rhodes and Cyprus. Because Cyprus was the ancient world's chief source of copper, the ship presumably loaded there.

From the description he received, Bass believes that the wreck is embedded in sand and that its wooden hull may therefore have survived. One goal of his institute is to trace the history of shipbuilding technology.

SubSea Surveys, utilising the ROV *Consub II*, carried out on-line surveys of the 32in. line from the **Ninian** Field to Sullom Voe. A similar potential monitoring survey was also undertaken on the **Murchison** to **Dunlin** 16in. flowlines. British Oceanics, operating with its manned submersible *LR II* surveyed the 18in. **Tartan** to **Piper** and 24in. Tartan to **Claymore** flowlines.

InterSub Services has recently carried out pipeline inspection work on **Casablanca** Field off Tarragona, Spain for Eniepsa. Using the manned submersible, *PC 1201*, the client's representative, a DnV inspector, was able to view for himself the condition of the pipe. Operated from the support vessel M/S *Nader*, the submersible was equipped with a new colour video camera, adapted by InterSub for use underwater. Instruments specific to this kind of survey allowed information regarding the burial and cathodic protection of the pipe to be measured and recorded. More than 84hr of dive time were necessary to inspect the pipe and obtain this data.

Find Could Alter American History

New York

Roman artifacts found in a bay near Rio De Janeiro may mark the wreck of a ship that could have reached Brazil 17 centuries before Portuguese adventurers discovered the region, according to a leading underwater archeologist.

A large accumulation of amphoras, or tall jars, of the type carried by Roman ships in the second century B.C. has been found on the bottom of Guanadara Bay, 15 miles from Rio de Janiero, according to Robert Marx, a well-known hunter of sunken treasure and specialist in underwater archaeology.

He believes the amphoras mark the wreck of a Roman ship that reached Brazil 17 centuries before the historical discovery of that region in 1500 by the Portuguese navigator Pedro Alvares Cabral. Marx said Saturday that Portuguese authorities are trying to block issuance by Brazil of a permit to excavate the shipwreck he thinks is buried there.

Amphoras are tall jars tapering to the bottom and usually fitted with twin handles. As described by Marx, they were to the ancient Greeks, Romans and Phoenicians what the five-gallon jerry can was to mobile units in World War II. They were used to carry wine, oil, water or grain on long voyages.

According to Dr. Harold E. Edgerton of the Massachusetts Institute of Technology, a pioneer in underwater photography who has worked extensively with Marx, the amphoras are definitive, both as to the age in which they were used and the identify of the users. Reached by telephone, Edgerton said of Marx's qualifications: "For my money he is as reliable as they come."

Marx, interviewed by telephone at his hotel in Rio, said he suspected a hoax when he first heard of the amphoras, but was convinced a few days ago when he dove on the site and saw an area comparable to three tennis courts strewn with jars, most of them broken. He has brought some to the surface and plans to have their age and origin authenticated by specialists.

The amphoras could not have been planted there, he said. Four intact amphoras and parts of at least 50 more are on the surface. Digging with his hands into the mud he encountered some as much as five feet down. The jars are barnacle-encrusted and some long ago became enclosed in coral. Marx believes all coral in that area was killed by pollution 30 or 40 years ago.

For many years he has sought to prove that other Europeans had reached the Americas long before Columbus. Because of his well-known interest in this subject, he said he was suspicious when informants sought him out to report the Brazilian finds.

For a number of years fishermen had reported snagging their nets on sunken jars in that area. They were assumed to be "macumba jars" thrown into the sea with native offerings to appease the sea gods, but such jars are usually smaller than amphoras, Marx said.

Divers in search of lobsters in the area, which is on the approach path to the Rio airport, brought up some jars as souvenirs. Last December Marx saw one in a Brazilian's living room.

Six years ago a diver named Jose Roberto Teixeira located the site and recovered two complete amphoras. He led Marx to the site.

Marx, the author of numerous books and articles on early exploration and underwater archaeology, believes the amphoras were carried to Brazil on a Roman ship that was blown off course. It may have anchored off Rio, then been driven by a storm onto the reef near where the amphoras now lie.

To reach the harbor, he said, it had to be navigated and therefore could not have been an unmanned derelict.

Marx has formed a company with Teixeira to excavate the site and, if granted permission to do so, has offered to donate all finds to the Brazilian government. Mapping the site will be difficult because the water is so polluted one can see only a few feet, if at all.

Marx hopes with sonar or other devices to probe the mud in which he believes some of the vessel's wood may be preserved. Recovery of weapons, tools and other relics of Roman type would leave no doubt about the nature of the ship.

"If we only find amphoras," Marx added, "then I'm in trouble."

Royal Navy's first submarine found

SUNDAY TELEGRAPH REPORTER

THE last resting place of Britain's first submarine has been found by Royal Navy divers near the Eddystone lighthouse, south-west of Plymouth. She sank in 1913 on her way to the breakers yard.

H.M. Submarine One, or Holland One as she was popularly known, is in perfect condition, and will be raised next year for the Royal Navy submarine museum at Gosport.

The National Heritage Memorial Fund has agreed to give the museum £10,000 towards the cost of preserving the vessel, the only surviving example of the world's first submarines as designed by the inventor, the Irish-American, John Philip Holland.

Commander Richard Compton-Hall, director of the museum, said yesterday: "It is very exciting. The Americans, the Russians, the Swedes, the Dutch all had the same design, built on licence from America, but there are none still existing."

The search for the submarine started earlier this year after Commander Compton-Hall received a cutting from *The Daily Telegraph*, which described the submarine's sinking.

From the position of the sinking given in the cutting, and reports of the weather, tides and currents at the time, the Commander estimated where she should by lying and asked Royal Navy ships in the vicinity to watch out for any signs of the wreck.

The submarine was found 180 yards from the spot pinpointed by Commander Compton-Hall and divers brought back a video tape showing its excellent condition.

The Navy has agreed to help salvage the ship next August as part of a regular training exercise. She is to be towed to Plymouth harbour, where she will be cut in three parts, brought to the surface, and coated with rust converter.

"We have been told that we have only 24 hours to treat her once she reaches the air before she becomes a heap of rust," the Commander said.

WESTERN REGIONAL UNDERSEA LABORATORY PROGRAM

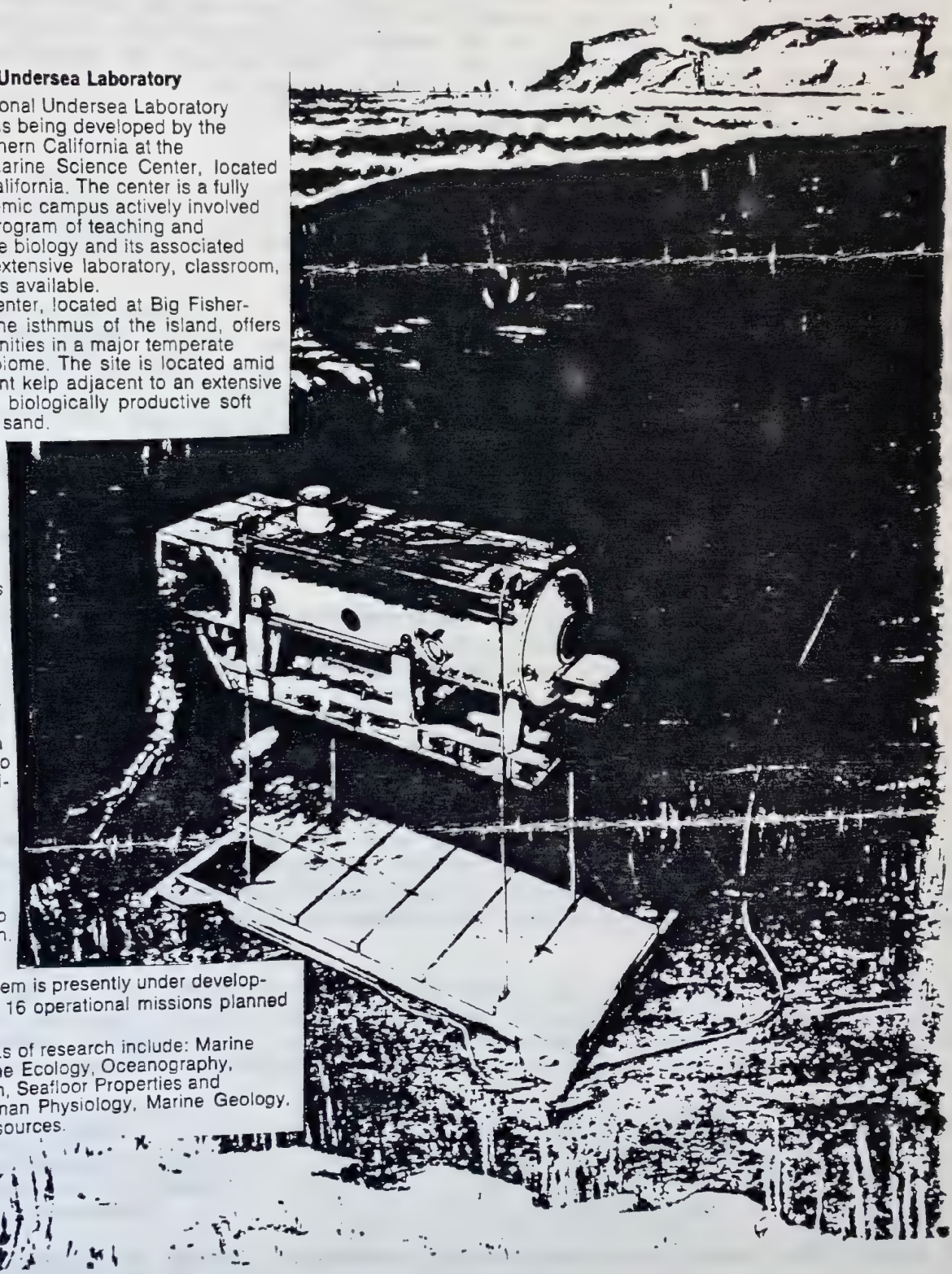
PROPOSED SATURATION DIVING SYSTEM
University of Southern California
Institute for Marine and Coastal Studies

Western Regional Undersea Laboratory

A Western Regional Undersea Laboratory (WRUL) Program is being developed by the University of Southern California at the Santa Catalina Marine Science Center, located off the coast of California. The center is a fully operational academic campus actively involved in a year-round program of teaching and research in marine biology and its associated disciplines with extensive laboratory, classroom, and living facilities available.

The science center, located at Big Fisherman's Cove at the isthmus of the island, offers research opportunities in a major temperate water undersea biome. The site is located amid a lush bed of giant kelp adjacent to an extensive rocky reef and a biologically productive soft bottom of shelly sand.

An undersea saturation habitat, manned by four personnel, is planned as the research facility. It will provide scientists with both living and laboratory quarters and the ability to enter into the water and conduct *in-situ* operations. Mission duration will be one to two weeks. The habitat sites will be at depths ranging from 50 to 90 feet in the well-sheltered cove having direct access to the open ocean.



The habitat system is presently under development with 12 to 16 operational missions planned per year.

Possible areas of research include: Marine Fisheries, Marine Ecology, Oceanography, Marine Pollution, Seafloor Properties and Processes, Human Physiology, Marine Geology, and Energy Resources.

(Too late, but of interest!)

AN INVITATION TO USE THE SUBMERSIBLE MAKALI'I AND OTHER FACILITIES OF NOAA'S REGIONAL UNDERSEA RESEARCH PROGRAM IN HAWAII

(Second Announcement of Opportunity)

The Hawaii Undersea Research Laboratory (HURL) is one of four current regional undersea programs sponsored by NOAA designed to improve our ability to understand and manage marine resources. HURL facilities, managed by the University of Hawaii under contract to NOAA, are located at Makapuu Point, Oahu. Its two-man submersible, Makali'i may operate anywhere in the Pacific, is certified for depths to 1200 feet, and may make dives of up to five hours in duration. Other facilities include a launch and recovery transport vehicle and support vessels.

As a result of the previous announcement, proposals have been received and selected based on peer review by members of the scientific community. Sixty-five dives have been completed and an additional eighty scheduled during the period of July 1981 to September 1982.

This is an invitation to submit proposals (for the period of October 1, 1982 to September 30, 1983) for the use of the submersible. Those wishing to participate in this program should identify areas of scientific investigation which include assessment and development of marine resources and ecosystem dynamics relevant to improving management of marine resources. Examples of research topics are as follows:

(1) Fisheries: ecosystem assessment and tropic dynamics, habitat degradation and enhancement, and animal behavior.

(2) Pollution: manner and physical effects of waste disposal, behavioral and physiological responses of marine organisms.

(3) Sea floor properties and processes: geological, geophysical, and geochemical aspects of the sea floor, including sediment transport, stability, fluxes, mineral resources and gradients in the water column.

(4) Impact of energy development: OTEC.

(5) Ocean technology and services: equipment testing, biomedical research and marine archaelogy.

Proposals received will be evaluated using the scientific peer review system. High priority will be given to proposals that exploit the unique capabilities of the submersible and are designed to produce results applicable to problems encountered in the Pacific Ocean. Those not accepted will be able to resubmit new proposals for consideration in subsequent mission proposal solicitations.

The use of the submersible will be provided at no cost to the scientists whose proposals are selected. Salaries and expenses for the scientific participants are expected to be provided by their parent organization. Investigators wishing to submit proposals or need further information concerning proposal submission should contact:

Mr. William Busch
NOAA (RD/SP2)
6010 Executive Blvd.
Rockville, MD 20853
(301) 443-8391

OR

Dr. E. H. Chave
Hawaii Undersea Research Lab.
Makai Pier, Makapuu Pt.
Waimanalo, HI 96795
(808) 259-9991

The deadline for proposal submission for missions during October, 1982 through September 30, 1983 is May 31, 1982.

French CNEXO Spearheads Ocean Technology Development

By Michael Mulcahy
Managing Editor

Paris, France—The Centre National Pour L'Exploitation des Oceans (CNEXO) was founded in 1967 by the French government to serve as a governmental research organization working with both public and private organizations "in order to advance... knowledge of the sea, to promote and conduct studies and research leading to development of ocean and seabed resources." CNEXO headquarters is here on the sedate Avenue d'lena, near the U.S. Embassy.

In practice, CNEXO functions as a major source of basic technology and serves as a national research and development consulting bureau for institutions and companies engaged in ocean science and engineering. Funding for calendar year 1982 (there are no fiscal years in France) is FF 400 million.

Resources available to CNEXO are substantial. Employees number over 1,000 in four locations. Eight research vessels, total crew of 200, a research submersible, 500 staff engineers and scientists and three laboratories, one of them in distant Tahiti—all form parts of the CNEXO web of influence on ocean matters in France. Some 80 employees are assigned to the Paris headquarters; 600 to Brest; 100 to Toulon; and 80 total to Tahiti, Martinique and la Reunion in the Indian Ocean.

Technical Personnel

A multidisciplinary team of scientists and technicians represent the fields of ecology; fisheries; aquaculture; physics; chemistry; geology; geophysics; economics; and data processing. When appropriate, the organization calls on assistance from outside sources, often universities.

This summer a new president director general was appointed. Yves Sillard, who achieved a distinguished career at the Centre National d'Etudes Spatiales—comparable to the U.S. NASA—took over the post from Girard Piketty. Two of Sillard's top assistants are Claud Riffaud, Inspector General, and Lucien Laubier, Scientific Director.

Riffaud, a submersible operations specialist, was director of the French portion of Project FAMOUS (French-American Mid-Ocean Undersea Survey) in 1973-74. Laubier was director of program management under Piketty. Jean Claude Pujol is Director of Industrial Programs.

Yves Sillard, Director-General

CNEXO's philosophy is to catalyze evolution of scientific research, when appropriate, into industrial development. Its role ends when conditions are economically ripe for passing into the industrial phase.

As CNEXO pursues part of its work through letting contracts to universities, efforts are made to distribute contracts uniformly among qualified universities.

Vessel Operations

CNEXO took delivery of two ships, the *Jean Charcot* and *La Pelagia*, in 1968, and has since had six other ships built. The vessels are used primarily by biologists, geologists and physicists. The *Charcot*, named for the French Antarctic explorer, is capable of real-time bathymetric mapping of the seafloor using the SEABEAM multichannel echosounder, made by General Instrument Corporation. Of the eight ships, ranging from 25-75 m in length, two are classified as multipurpose oceanographic ships, while others' specialties range from tropical and cold water fishing to support of undersea reseach devices. The newest vessel, the *Thalia*, was launched in 1978.

Underwater Activities

Over the last decade, France has established itself as a contributor to undersea technology. Applicable fields include diving and manned and unmanned submersible operations.

In 1970 the Operation *Janus II* diving experiment proved that work could be performed at depths of 200 m. The experiment was partially supported by CNEXO, and partially by ELF-ERAP oil group.

Two years later, in an experiment called *Physalie VI*, a simulated diving record was set at the depth of 610 m in a pressure tank. The French diving company COMEX conducted the tests, as part of the CNEXO program.

In 1977, in Operation *Janus IV*, a world diving record to the depth of 460 m in the open ocean, and an excursion to 501 m, was set. Participants included COMEX, CNEXO, the French Navy and ELF-Aquitaine.

Submersibles

In this field, CNEXO operates the deepwater submersible *Cyana* for scientific and industrial use. The objectives are to make deepwater vehicles available to scientific and industrial users; and to support efforts by French industry to sell and export submarines.

Project FAMOUS involved exploration of part of the Mid-Atlantic Ridge (See *ST*, Oct. 1974, p. 16) by submarines, in cooperation with the

U.S. Operation CYAMEX, (the name is a blend of the names *Cyana* and Mexico) which was carried out off the Pacific coast of Mexico in February and March 1978. The collaboration with geological teams from the U.S. and Mexico gave CNEXO the opportunity to develop deepwater navigation techniques.

The bathyscaphe *Archimede*, tested in the water for the first time in 1961, has remained largely an experimental vehicle. It was operated first by the French Navy and since 1969, by CNEXO. The goal was to produce a vehicle capable of taking men to the deepest trenches of the sea—11 km deep.

Cyana, formerly the *SP-3000*, was launched in 1970, and was designed as a lightweight observation submersible capable of working to 3 km depths. Since 1974, the sub has made over 250 dives, of which 80 were scientific and 130 under industrial contract.

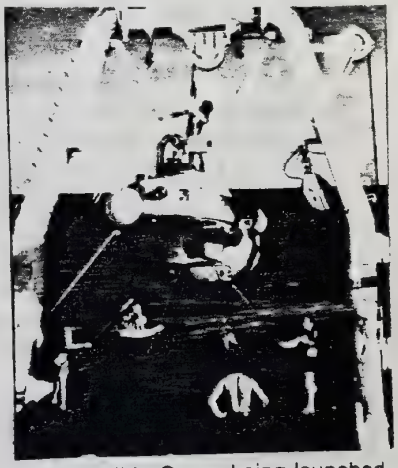
Plans are progressing on schedule for a 6 km undersea vehicle, to be jointly developed by CNEXO and the French Navy, which is defraying a part of development costs. Its titanium sphere is scheduled to be tested by the U.S. Naval Ship Research and Development Center in the fall of 1983, with completion of the vehicle by early 1984.

The new submersible, called *SM-97*, has been under development since 1978. The significance of its name is that it is expected to be able to go to 97% of the world's ocean depths with its 6 km operational depth limit. It eventually will take the place of the *Cyana* in deepwater work. The titanium sphere reaches 18 tons of compression during dives. Like the *Cyana*, the *SM-97* will have capacity for three persons—pilot, engineer and scientist.

In 1970 CNEXO, to meet the demands of deepsea biology and geology, acquired the *RAIE* (Skatefish) series of towed equipment. The present generation, *RAIE II*, dates to 1978, and consists of an open frame carrying a small echosounder and a Benthos Model 377 undersea camera. It is used to map and photograph nodules on the ocean floor, working to 6 km depths. Reportedly a subbottom profiler, temperature probes and sidescan sonar will be added later for exploration of hydrothermal deposits and vents.

In 1976 CNEXO began a study of a second generation of more efficient equipment for data gathering at great depths. From this study emerged the *Epaulard*, an autonomous robot which can operate to 6 km, with speed and direction of heading acoustically controlled from its support ship. After tests in 1979, the *Epaulard* has proved to be valuable for data gathering in oil or undersea mining applications. It is the only unmanned, untethered submersible in the world capable of 6 km operations. It can work eight hours at two knots.

The Orque (ORC), derived from the *Epaulard*, is under development. It should be able to carry out deep site inspection with online data transmission when it enters service.



Submersible *Cyana* being launched.

Mineral Resources

Since 1968 CNEXO has worked with private industry and scientific research teams to search the seabed for marine mineral resources, in both domestic and international programs.

These programs include the International Phase of Ocean Drilling (IPOD); FAMOUS CYAMEX; and the Geochemical Ocean Sections Study (GEOSECS), a part of the International Decade of Ocean Exploration (IDOE), which ended in 1981.

The inventory of mineral resources in the French continental shelf is carried out by CNEXO in collaboration with the Geological and Mining Research Bureau (BRGM), or Bureau de Recherches Géologiques et Minières, which is responsible for publishing geological maps of the country and its continental shelf.

Sand and gravel are the principal resources of the French continental shelf. Studies of other resources, such as phosphates or ilmenite, are planned to be extended to continental shelves of Third World countries, which would be supplied by CNEXO with appropriate expertise.

Deepsea Mining

Hydrothermalism and chemical alteration of fractured basalt on the ocean floor, with accompanying concentrations of metal deposits, have been subjects of intrest to CNEXO geologists for several years. During the 1973-74 Project FAMOUS, hydrothermal vents were discovered in the mid-Atlantic. Mineral-containing muds were found during IPOD drilling in the 1970s. Sulphur samples assaying up to 24% of zinc were collected during CYAMEX. The expedition used the support ship *Nadir*, a CNEXO vessel, as mother ship for the *Cyana*. From the surface the ANGUS (Acoustically-Navigated Geophysical Underwater Survey System) performed parallel photographic studies of the East Pacific Rise at 21° North latitude just south of the tip of Baja California.

Although estimates vary considerably on the economic value of these deposits, their existence has quickened the pace of French interest in the deep ocean floor, especially in rift and fracture zones.

Polymetallic Nodules

For more than a decade CNEXO scientists have studied the prospects of polymetallic nodule concentrations on the seafloor—including manganese—where accompanying nickel, copper and cobalt are likely to be commercially producible.

The French Association for the Study and Research of Nodules (AFERNOD), involves, in addition to CNEXO, the French Nickel Company; France-Dunkerque Shipyard; Mining and Geological Research Bureau (BRGM); and CEA, the Center for Atomic Energy.

Various systems for recovery of polymetallic nodules have been evaluated, with no ultimate commitment to a single approach. One option is a mechanical bucket dredge, tested in 1970 and 1972 by an international group of interested powers, including the U.S., Australia and Canada, in addition to France. AFERNOD holds the patent on the system.

Seismic Survey: A Booming Business

'Sierra Madre Boys' Turn Into Multi-Million Dollar Nekton Firm

OCT 82

By HELEN CALL
Financial Writer, The San Diego Union

Almost 30 years ago, a small group of diving geologists from the old Navy Electronics Laboratory and Scripps Institution of Oceanography worked on weekends mapping the ocean floor at Newport Beach for an oil company. They called themselves the Sierra Madre Boys after a movie of the time, "The Treasure of Sierra Madre."

Robert F. Dill, now chief scientist with the U.S. Office of Ocean Minerals and Energy and one of the group, recalled those days: "Our main reason for calling ourselves the Sierra Madre Boys was that greed for gold was featured in the movie. We all hoped that we too would become rich some day by doing outside consulting work. I find it hard to believe that that band of cold divers has now grown into the Nekton corporation."

Dill's comments were made in a letter to Nekton on the background of the company, which officially began in 1955 in San Diego. Through the years, the company has evolved to the point that it is thinking about "going public," or selling stock in the company to the public.

Sales last year were $6 million and growing. It won't be tomorrow that going public happens, according to Nestor Stone, director for human resources, because auditing procedures and other preliminaries must be completed — perhaps a year or so, he says.

In an earlier interview, Nekton president Carroll L. Hoyt said going public would "gain some liquidity for the existing shareholders who have been without liquidity for 25 years. The individuals sell their shares privately; we build up the company so it can be sold and everybody gets rich. Or we take the company public and make it grow. My mandate when I arrived here (in 1974) was to make the company grow, so that is what we're doing."

Nekton is an oil service company, with about 65 employees based in Sorrento Valley. It uses sound to explore the land mass under the sea, hoping for "bright spots" that could indicate the presence of oil or gas.

"The seismic industry is a very large business — about $3 billion to $4 billion annually," said Hoyt. "We emphasize high resolution, and not too many companies are doing that. We are a leading company in our particular niche."

In spite of the recent global oil glut, petroleum companies are convinced that the need for oil will rise again and the price will go up. They are cutting back on their exploratory enterprises, according to Nekton's Francis Monastero, vice president for business development, and spending more on the preliminary findings of companies such as Nekton.

"Seismic survey is becoming the most important means of locating oil and gas, next to actually drilling holes," Monastero said. "The reason is it costs only 5 percent of what it costs to drill a hole to run a complete seismograph. This data pinpoints the location of structural traps with a potential for holding oil. Of course, eventually there is no substitute for putting a hole in the ground."

With this in mind, Nekton plans to grow — possibly in all directions at once. Hoyt says it is inevitable that they will go into handling their own data processing, which now costs them $1 million a year. Nekton already has taken over its own navigation work — precision positioning of a surface vessel for mapping the sea floor.

In its early years, the company provided underwater pipeline inspection, using its little fleet of two-man submersibles. Then came sea-floor sampling and geological hazard surveys. With high-resolution exploration surveys, Nekton teams took to surface ship operations.

But occasionally the submersibles come out again. The company says it has probably been doing commercial submersible work longer than any other company in the world. It certainly has the expertise aboard in Thomas Vetter, manager of special projects for Nekton, who joined the company four years ago

Vetter was a submarine officer in the Navy, where he operated the deep-diving submersible Trieste II. He set a record with the craft, which he describes as about the size of a Greyhound bus, reaching a depth of 16,130 feet. The miniature submersibles at Nekton go down about 1,000 feet.

The submersibles were put to work on a project Nekton has just completed — a study financed by seven oil companies to find out how to evaluate evidence of gas seeps in a water column.

"This study is unique — it has not been done before," said Hoyt. "We wanted to evaluate the anomalies seen in water columns. We thought we could generate artificial seeps with our submersible and compare them with natural seeps.

"We did this — our submersible made 70 dives to different depths and released varying quantities of gas from metered openings. Simultaneously we ran our research vessel over the rising gas plumes with the seismic recorder. We then surveyed natural seeps. It's a tremendously complex problem, far more difficult than it sounds.

"We did find some new things, although they are not really revolutionary. But we did a far better perspective of the meaning of gas seeps as seen on seismic records and the limitations of interpreting them."

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

MARCH, 1983

Vol. XVI, No. 1, Published by the Deep Submersible Pilots Ass'n

The Deep Submersible Pilots Association was formed in 1967 to provide for a free interchange of information relative to deep submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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Correspondence regarding new member applications should be addressed to :

Willis Forman
Membership Chairman & Vice President, DSPA
1527 Linwood Street, Apt. 5
San Diego, CA 92103
(619) 295-0620

EDITORIAL NOTES AND COMMENTS

A rousing, if belated, "Welcome on board" to new Members:
Derek Williams of HMB Subwork,
Tim Caffarella of NEKTON,
Wayne Orrison of DSRV-1 (MYSTIC),
Don Liberatore of Harbor Branch Foundation,
and to new Associate Members:
Allan May, Captain , USN (Ret),
Ken Mackenzie, scientist and engineer in oceanography and underwater sound.

Tom Vetter has left the civilian world of NEKTON, Inc. and returned to active duty in the U.S. Navy on the Staff of Submarine Development Group Two. Tom has also taken over the duties of DSPA Secretary from John Schiltz. Best wishes, Thomas!

It is evident from the letters we receive requesting T-shirts, etc., that most Members are unaware that Will Forman, in addition to his long tenure as Membership Chairman, is also our principal procurement agent and storekeeper. I guess I should add shipping agent to that list. You employed working people with one job wouldn't believe the number of activities in which Will is heavily involved. Will is the perennial volunteer. Just possibly that explains why he has the appearance and enthusiasm of a youngster.

It has been our practice to send out new membership cards attached to Newsletters or enclosed with other mailings. They might easily be overlooked and discarded. Please be aware and check for them in the future.

In this day of high speed communications, one may find that reliance on "surface mail", particularly for overseas routes, brings sorry results. For instance, Alan Whitfield's IUPA Newsletter frequently takes two or more months to travel from England to San Diego. Several years ago, we stopped trying to save postage when it became evident that other than air mail resulted in unacceptable delays in delivering our Newsletter. The delay in my typewriter is bad enough without stretching it in the mail!

You will find no address corrections at the end of this NEWSLETTER. The recent address list revision contained a plethora of errors and will be replaced as soon as possible. Once again, please keep the Secretary advised ASAP of changes in your mailing address and employment. Oh, the aggravation of painstakingly producing a new address list and immediately afterwards receiving a batch of six-months old address changes!

ROV '83- The MTS Remotely Operated Vehicle Conference & Exposition was held March 14-17 at San Diego, CA. To date, I have not received a report and was unable to attend. The program looked very interesting and ambitious. Bob Wernli of NOSC was the driving force.

DSPA MONTHLY LUNCHEON MEETINGS continue to be held at Tarantino's in San Diego on the third or fourth Thursday of the month, usually with a guest speaker. Members from out of town planning to visit San Diego should get in touch with the DSPA President or other local Member to ascertain the date or perhaps to get the date changed to conform toan unalterable visit schedule.

OCEANS '83- Make your plans now to be in San Francisco August 29-31. Hopefully, we may have enough Members on deck to have a DSPA meeting. At least, it will be an opportunity to get together, swap experiences, etc. Perhaps Don Saner can promote an invitation to DSPA Members to rally in the Lockheed suite at the Hilton.

))) **Oceans '83 Format Changed.** As promised at Oceans '82 in Washington last September, Oceans '83, to be held at the San Francisco Hilton Hotel August 29-31, will be different. According to information released recently the tentative program will offer only one day of formal papers instead of three days as in the past. That one day will be Tuesday, August 30. The first day, Monday, will be devoted to an overview, beginning with a blue ribbon panel in the morning and the afternoon devoted to panels on Mineral Resources and Energy, Non-Mineral Resources, Ocean Science, Transportation, and Military Ocean Engineering. The last day, Wednesday, will feature focal programs in the morning and the closing plenary review and critique of the blue ribbon panel in the afternoon. The Chairman's Luncheon will be Monday, the Banquet Tuesday and the Awards Luncheon Wednesday.

NEWS FROM MEMBERS

John Donnelly--Woods Hole Oceanographic Institution (11/10/82)
"Now that the conversions of ATLANTIS II and ALVIN have been approved and funded, both the ALVIN Group and I have found that the project is a very demanding one on top of the day-to-day operational requirements. This been compounded by delayed funding from the Federal agencies which has forced a compressed time for the accomplishment of the conversion. Of course, none of this was foreseen clearly back in March.- - I feel that the DSPA Newsletter would not get a fair shake in my hands given the present circumstances, and therefore I am compelled to rescind my offer.- - As to my new job.I now have responsibility for all of the Woods Hole ships and boats including ALVIN. Barrie Walden has succeeded me as Manager of the ALVIN program."

Vance Bradley--(01/01/83)
"To update my status: I am no longer employed by the Harbor Branch Foundation. At the moment I have no business as such, so that space on the Membership list must remain blank for the present. More is the pity.- - At the moment, the closest thing to the manned submersible field is a K-350 in my side yard- mostly disassembled just now. I own a piece of it in return for turning it into something a little more modern than it was when built. A proper electrical system and life support system are on the bench, hydraulics and a manipulator on the drawing board.- - I keep thinking I'll wake up one morning to find the elves have turned it into a Perry boat overnight."

Alan Whitfield--H.M.B. Subwork (01/02/83)
"Please find enclosed the January 1983 I.U.P.A. Newsletter which containstwo interesting articles on submersible news. I am still running the MANTIS/Borgney Dolfin contract offshore Norway. At present, we are the deepest diving system in the North sea, usually operating at 1200 feet in the Norwegian Trench. However, the hole we are supporting today is in shallow water at 350 feet. At the end of February though, it is back north to deep water.- - As you no doubt have been reading, the new MANTIS vehicles are capable of being operated either manned or unmanned. Ideal for diving conditions where safety is a major concern. The first of H.M.B. Subwork's dual role MANTIS has just been sent out to one of our Canadian contracts."

OCTOBER 1982.

SCANNINGS.

1.Oceaneering is to put Arms IV. onto the Blue Dolphin dive support vessel. Working off Santa Barbara,California.

2.Oceaneering Arms I. is still on the Glomar Atlantic offshore California.Diving to 1040ft.(Flaherty,Starr, Peterson,Meyer.)

3.Oceaneering Arms II. is in the Labrador Sea ,diving to 400ft.(Smale,Simpson-Place,Bunce.)However Bunce is leaving to join Solus Ocean Systems.(OMB, offshore Australia.)

4.Other pilots who may join the OMB project include : T.Webb,D.Fairburn,Taff Jones, P.Sheader.

5.Oceaneering also now has two ADS systems based in Morgan City,Louisiana.Each system comprises one Jim + one Wasp.

6. Bill Ranson (ex VOL, and HMB) has left the industry, and is now general manager for Wood Group Structural Coatings.

7. News from the Scarabeo deep drilling rigs. Scarabeo 3. (Saipem) is reported to have the PC1602 on board. Working offshore Libya for Agip. Scarabeo 4. has an Oceaneering Jim system.

8. Spie Offshore has taken over Norsub Willco. The new company will be called Norsub Willco.

JANUARY 1983.

SCANNINGS.

1. EEP. ltd, of 168. Cheltenham Rd, Bristol, are looking for submersible engineers with concept design experience.
   Comex are looking for pilots, to operate the new Pc1805 (Stadive), which has been undergoing trials at Fort William.

2. News from Australia sent by Tony Webb. Video Systems is running a RCV 150 for Woodside Petroleum. (Pipeline survey). SSI have a scorpio working with Comex off the west coast. Taylor diving also had a short RCV225 contract, rock dumping survey.

3. Solus Ocean Systems are also operating two OMB units offshore Australia.

4. Anyone planning a move south is reminded that all offshore workers have to join the union.
   Professional Divers Association, 90. Queen St, Melbourne, Victoria, Australia.

5. For more information concerning working conditions, please contact me and I will put you in touch with Tony Webb, or one of the other members.

6. IUPA membership renewal for 1983 is now due. Please complete the form below, and return it to me. No form, no newsletters.

ED.

IUPA MEMBERSHIP RENEWAL.

Name : Tel:
Address :

Company : Position:
Project and Subs currently involved with:

Enclosed is £5.00 (cheques to IUPA) for 1983 membership.

Signed : Date:

Kevin Parker--H.M.B. Subwork (01/24/83)
"I received your card and the first Newsletter for nine months two weeks ago. While I was away in Canada, my wife also received three letters I had sent to W. Forman , one of which included my subscriptions from last year. I also sent several letters concerning activities with H.M.B. Subwork and their joint venture contract with Hydrospace Marine Services of St. Johns, Newfoundland. I wouldalso

like to update my personal information file. I left Oceaneering almost two years ago. I am mow employed as a Senior Pilot with H.M.B. Subwork Ltd. on the M.S.V. BALDER CABOT, working out of St. Johns and Mulgrave in Nova Scotia. You have me down for LEO, MERMAID, and P.C.9. It should read: LEO, MERMAID 3 and 4, P.C. 9, PISCES VI, ARMS Bell III, and R.C.V. 225 No. 29 and 34, as well as ORCA One. My phone number is 0254-771156 (not 77156).- - Could you please send several membership application forms to Hydrospace Marine Services, Nord Bldg., Vanguard Court, P.O. Box 13187, St. Johns, Newfoundland A1E 4A4, Att'n Mr. Max Ruelokke, V.P. I seem to have read somewhere that MANTIS pilots do not qualify for full membershipbut may qualify for Associate Membership."

Jim Beachler--SALT LAKE CITY - SSN 716 (02/15/83)
"My addresses have changed as follows:

RES: 115 Central Pkwy
Newport News, VA 23606
(804) 599-6985
BUS: PCU SALT LAKE CITY (SSN 716)
Supervisor of Shipbuilding
Newport News Drydock & Shipbldg
Newport News , VA 23607
(804) 380-7246 "

Tim Askew--Harbor Branch Foundation (02/02/83)
"Just a few lines to bring you up to date on Harbor Branch Foundation plans for this year. We are looking into the possibility of reclassifying our two JOHNSON-SEA-LINK submersibles from the present 2,000 feet to 3,000 feet. We are bogged down with paperwork (ABS) and may have to wait until 1984 to chamber test the vehicles at the David Taylor Naval Ship R & D Center. Also, we have signed a contract to design a new larger support ship to replace R/V JOHNSON. Once the drawings are complete, we hope to go ahead with construction sometime this year. The new vessel will be called R/V SEWARD JOHNSON and will be 166 feet long and 36 feet wide, giving us the capability of carrying two submersibles and a deck decompression chamber. This summer, we will be working with National Marine Fisheries in the Gulf of Maine and the Georges Bank area as well as the Bahamas where we have several on-going science programs.-- Last December, we did some filming with Al Giddings for Disney World using their new 360° underwater camera. Aldo, we had the pleasure of having Jack Birns, from Birns Oceanographics, spend deveral days with us for light evaluation dives. With Jack's expertise in lighting, we were able to make several improvements to our system, giving us more usable light at much less current draw on our batteries.- - I hope to be giving a paper at Oceans '83 this September on lightweight composite cylinders for submersibles. At the present time, we are finishing a three year surveillance test program in cooperation with Acurex corporation, Aerotherm Division, utilizing 36 cylinders. The results so far have been impressive , and D.O.T. acceptance should be forthcoming.--Hope to see some fellow Members in San Francisco at Oceans '83."

Jerry Shiller--NEKTON, Inc. (02/26/83)
"NEKTON continues to be busy, primarily with seismic work. in addition, we just won a contract from Texaco to do a biological investigation with a submersible for a new platform site west of Pt. Conception."

Gary Rees--U.S.Navy (undated)
"Please note that my address has changed. I am now the Executive Officer at Submarine Training Facility, San Diego. I hope to make it to more meetings now."

SUBMERSIBLES COMMITTEE (SOCIETY FOR UNDERWATER TECHNOLOGY) - AUTUMN 1982. (U K)

The Committee has drawn up a proposed draft syllabus and selection standard for submersible pilots. The draft was forwarded to many interested parties both in this country and abroad and their comments have been incorporated in a submission to the Department of Trade. An agreed standard is considered vital to maintain safety.

The Committee is now turning its attention to the problems of vehicle work in deep water and the requirements, specifications and costs of a shore-based remotely operated vessel pilot trainer.

Challenger Marine Relocates To Titusville, Florida

Challenger Marine Connectors, formerly of San Diego, Cal., has relocated to Titusville, Fla., and in doing so has expanded its manufacturing facilities. The company's primary product is a line of wet-mateable coaxial connectors (said to be the first on the market) for offshore and oceanographic underwater electrical signal and power applications.

In the near future, the company plans to introduce a line of general-use wet-mateable multiple contact power connectors, as well as a connector which will pass one electrical and one optical contact.

The company's new address is: 1625 White Drive, Titusville, FL 32780; (305) 267-1855.

Lavalin Ocean Systems Formed In Canada To Provide Underwater Service

Lavalin Services, Inc. of Montreal (Quebec) Canada, and Solus Ocean Systems, Inc. of Houston, Texas, have agreed to form a jointly owned Canadian company to be called Lavalin Ocean Systems, Ltd. The company's headquarters will be located in Halifax, Nova Scotia.

Lavalin Ocean Systems, Ltd. will provide underwater marine services to the offshore oil industry in support of exploration, construction, and production facilities. **Claude Rouleau** has been appointed to represent Lavalin Services, Inc., and **Edmund L. Dunn** has been appointed to represent Solus Ocean Systems in this new venture.

The company will be located at Suite 1020, Cogswell Tower, 2000 Barryington Street, Halifax, Nova Scotia B3J 3K1.

Benthos Sells Two RPVs In First Production Run

Benthos, Inc., Falmouth, Mass., on January 6 consummated the sale of two RPV 430 remotely piloted systems to Geophysical Scientific Equipment Ltd., Luton, Hertfordshire, U.K. G.S.E. will offer the systems under the name "Ocean Robot" for North Sea commercial underwater inspection and survey work. Equipment included in the sale were vehicle-mounted Sub Sea Systems black and white video camera and Benthos camera and three-function articulator, manufactured by Deep Sea Systems, Inc., Falmouth, Massachusetts. Other options are available.

Soviet Satellite Demonstrates New Search and Rescue System

A Soviet satellite was primarily responsible for the prompt rescue of the pilot and passengers aboard a light plane which crashed in northern British Columbia, Canada in September. The satellite is equipped with instruments designed specifically to monitor distress signals broadcast on 121.5 MHz by aircraft ELTs (Emergency Locating Transmitters) or shipboard EPIRBS (Emergency Position-Indicating Radio Beacons). The system is equally applicable to ships and aircraft.

The Soviet satellite is part of an experimental search and rescue system being developed for maritime and aviation use by the U.S., Canada, France and the Soviet Union. The U.S. has teamed up with Canada and France to develop the satellite system, called SARSAT for Search and Rescue Satellite Aided Tracking. The Soviet Union is providing the use of two satellites and several ground stations, but is developing its own satellite technology, called COSPAS, independently.

Both the SARSAT and the COSPAS systems use a doppler location method to locate the source of emergency signals. As the satellite approaches the source, received electromagnetic waves are compressed. As the satellite moves away, they are stretched. This information is fed to a ground station for processing. With the use of an array processor, a probable transmitter location can be calculated within 15 minutes, with a predicted accuracy of 10-20 kilometers.

In the case of the Canadian airplane crash, the position calculated from the satellite data was only 22.5 kilometers off the true location of the crash. Canadian officials said that without the help fo. the satellite data, the search for the airplane would have taken at least three to four days longer.

The Soviet satellite, launched in June, is the first to be put into orbit in the four-nation program. It is in a near-polar orbit at about 600 miles altitude providing coverage every 10-12 hours. With each pass, the satellite monitors an area roughly the width of the U.S.

The first U.S. satellite to carry the SARSAT equipment will be the NOAA-E environmental satellite, scheduled for launch in February, 1983. The U.S. will provide satellite use plus overall system management. Canada will provide the satellite repeater which will relay emergency signals broadcast on either 121.5 or 243 MHz, and France will provide a data processor for an experimental system that would receive distress signals broadcast on 406 MHz, a frequency currently not in use for emergency broadcasts. The SARSAT project is being managed by the NASA Goddard Flight Center, Greenbelt, Md.

The SARSAT repeater can currently provide only regional coverage. It cannot process the signals and cannot store them, and must relay the data to a ground station in real time. The emergency transmitter and ground station must simultaneously be in line-of-sight view of the satellite. Ground stations in North America are located in Kodiak, Alaska; Point Reyes, Cal.; Scott Air Force Base, Ill.; and Ottawa, Ontario. Scott AFB serves as the international coordination center.

The experimental system, being developed by France, could provide global coverage. Emergency signals transmitted on 406 Mhz can be recorded by the satellite and fed to a ground station when the satellite passes overhead.

In addition to global coverage, the bandwidth would permit specific information to be transmitted. In the case of a ship at sea, information could include the type of ship, flag, ship registration number, and code which would indicate the type of emergency—crash sinking, fire, medical help required or disabled.

IMO Subcommittee Approves FGMDSS, EPIRB Rule Changes

At a meeting of the Subcommittee on Radiotelecommunications of the International Maritime Organization (IMO) in December it took two actions.

In one it approved a ship carriage requirements document for the Future Global Maritime Distress and Safety System (FGMDSS) with the stipulation that the requirements were agreed for vessels above 1,600 gross tons but would be considered further at subsequent meetings insofar as they apply to vessels between 300 and 1,600 gross tons.

Also, there was a compromise move to resolve years of discussion and controversy regarding the need for a 2182 kHz homing capability for EPIRBs (Emergency Position Indicator Radio Beacons).

It was agreed to drop further consideration of the 2182 kHz on the basis of the ten-mile range provided by VHF EPIRB frequencies, provided that there was a capability to update positions through use of polar orbiting satellites.

))) **SARSAT Rescues Continue.** The Search and Rescue Satellite-Aided Tracking system, called SARSAT, began making news last year when the Soviet satellite COSPAS began operating. (American satellites are scheduled for launch this year.) Downed aircraft crews and passengers, one group in Canada, the other in the southwest U.S., were saved. An aircraft or boat in distress turns on its Emergency Locator Transmitter (ELT) and a satellite will locate the vehicle in general terms from a 121.5 MHz signal and after the U.S. satellites are operating, 243 MHz. There are two international distress frequencies. The latter frequency produces fixes of five to ten miles. Late last year a trimaran in the North Atlantic sent its distress signal from 300 miles east of Cape Cod. Soon a U.S. Coast Guard C-130 aircraft was on the scene and hours later the three men clinging to the capsized craft were rescued. The COSPAS/SARSAT program is a joint one of the U.S., Soviet Union, Canada and France. The new U.S. satellites will also be able to pick up 406 MHz. New ELTs and Emergency Position Indicator Beacons (EPIRBs) are being developed to transmit on that frequency. The system is still experimental. One problem that needs to be curbed is the transmitting of "false alarms" by, for instance, a parked aircraft or persons deliberately using the distress frequencies for other purposes. U.S. coordination of rescue efforts originates at the U.S. Air Force Rescue Coordination Center, Scott Air Force Base, Illinois.

BRITISH OCEANICS

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MANNED SUBMERSIBLES

Observation and diver lock-out class. These craft are surplus to requirement and as such are offered at rates substantially below those of a "new-build".

The submersibles can be supplied 'as is where is' or completely classified together with a containerised support system.

British Oceanics also have available a limited number of handling systems.

For further information contact:
Ian Dempster, British Oceanics Ltd.
East Old Dock, Edinburgh.,Tel: 031 554 4411, Telex: 772248

OCEAN INDUSTRY, October 1982

KAWASAKI TOPICS

NO. 132 JAN., 1983

KAWASAKI HEAVY INDUSTRIES, LTD.

KHI to build first Japanese deep submergence rescue vehicle

KHI recently received an order from the Japan Defense Agency to build a deep submergence rescue vehicle (DSRV), the first such vessel to be built in Japan.

The vehicle will be built at KHI's Kobe Works and delivery is set for the end of March, 1985.

The deep submergence vehicle will be used to rescue crews from disabled submarines. After leaving its mother ship at sea, the vessel will approach a sunken submarine by means of a guidance system of the mother ship and by its own sonar system.

When the DSRV locates the sunken submarine, it will connect its hatch to that of the submarine, enabling the crew to move into the rescue vessel. Though this rescue work sounds easy, it is in fact very difficult. The rescue vessel must be able to maintain a precise position against strong tides and currents while deep under the sea to make successful mating and this will require automatic maneuvering control system, mating equipment, etc.

Conventional sea rescue systems employ a rescue chamber that is lowered into the sea from a mother ship. These systems, however, inherently have a limitation of the sea state and the depth at which the chamber can work.

The self-propelled DSRV, however, will be able to drive into a very deep sea, find a sunken submarine on its own and quickly connect its hatch with that of the submarine.

Ultra high-tensile steel will be used for the vessel's pressure hull and titanium alloy, FRP for the outer hull. The DSRV's equipment will all be light in weight and compact, but have high performance. A major part of the equipment will be installed outside the pressure hull so as to increase the vessel's buoyancy and effectively use the space inside.

The vessel will have a compact design to facilitate easy handling and increased maneuverability in the sea. To go into action in an emergency, checks of the DSRV's equipment will be accomplished automatically by checkout system on board and the reliability of all the equipment will be increased through dualization.

Upon completion, the DSRV will not only be able to rescue submarine crews, but may also gather precious data about the deep sea since the vessel will also be able to function as a general submersible research vehicle.

Principal particulars of the DSRV:

Displacement	: abt. 40 tons
Length o.a.	: 12.4 m
Breadth	: 3.2 m
Depth	: 4.15 m

Cruising speed under the sea: abt. 3 knots ●

Comex revives development of ambitious long-range submersible

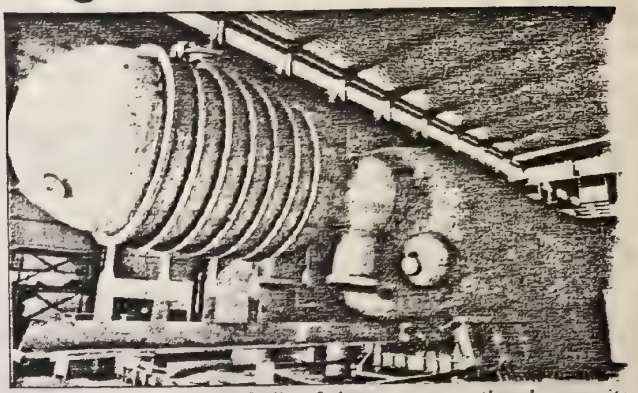
After a break of 10 years, the development of an ambitious long-range submersible, able to carry 10 people — including four divers in saturation — over distances as great as 250 nautical miles and with an endurance of two weeks, is to be revived following a decision just made by Comex SA of Marseille.

The *Argyronete* programme — for a prototype submarine work craft for petroleum and oceanological tasks — was initiated in 1967 by France's IFP and CNEXO (Institut Francais du Petrole, and Centre National pour l'Exploitation des Oceans). Four years later it was stopped by the French Government because it was considered too far in advance of industry's needs and because of technical stumbling blocks, not least in the propulsion plant, then based on lead/acid batteries. Aims were (and are) to provide a 600m capability, with diver lock-out down to half that depth.

By 1971, Fr30 million of the day (equivalent to about 90 million 1982 Francs, or £8.2 million at the current rate of Fr11/£1) had been spent on the 28m long, 250t vessel, bringing it close to two-thirds complete by the time it was mothballed.

On 15 February this year, Comex decided to buy up the equipment and finish the project, and the company is currently looking for European contributions towards the Fr60 million cost of the work.

New technologies and new industry demands help to make the project more feasible now, feels Comex. In particular the advent of closed-circuit diesel, and the Stirling engine — the two most serious candidates for powering such a vessel — make the project far mor viable. *Argyronete* will be used as a test system for such new energ packages, and for new techniques of inspection and repair fro submersibles. Comex expects to start a two-year fabricatio schedule by the end of this year, followed by one year of trials.



The completed pressure hulls of Argyronete, as they have waite in France for the last 10 years. In foreground is the chamber for u to four divers in saturation, then the lock-out facilities, and behin these, the main chamber of the 28m long vessel.

S.S.O.S Launches First Diver Lockout Minisub With Incorporated Closed Cycle Diesel Engine

The Italian underwater engineering firm S.S.O.S., based in Milan, has launched the world's first diver lockout minisub to incorporate a 90 HP closed cycle diesel engine. Launch took place at the firm's new base in Gaeta where final sea trials took place.

The Phoenix 1350 is designed for offshore civil and naval operations at maximum depth of 350 m. Its maximum working time on the seabed is 20 hours, which is a breakthrough in comparison with current limits. The longer operating period will also improve the chance of rescuing personnel trapped when a submarine is immobilized on the seabed, S.S.O.S. believes.

The minisub with powerful manipulators is essentially a multipurpose vehicle for transportation of saturation divers to their work location down to a maximum depth 351 m. its underwater range is 250 nautical miles and maximum speed is 9 knots below the surface (6 knots on the surface).

The pressurized lockout chamber can accommodate four diver technicians, whose working functions are facilitated by the accurate positioning capability afforded by the very powerful thrusters on the outside of the submarine.

As the problem of cold affecting saturation divers at such depths is solved by the unlimited heat source from the engine itself, there is no need for any support vessel on the surface to supply heat via an umbilical or for any other purpose.

The incorporated closed cycle diesel engine has no external atmospheric intake/discharge, since after purification the exhaust gases are recycled to the engine intake itself, with variable input of oxygen as required.

Further data on the Phoenix 1350 are as follows: overall length 11.4 m; width 3.0 m; height 3.0 m; weight 25 tons; collapse depth 701m; life support system for 192 man/hours in operation and 576 man/hrs in an emergency.

Marine Technology Society—

Dr. John P. Craven—*14th Lockheed Award for Ocean Science and Engineering*

This award is sponsored by the Lockheed Corporation because of its deep and continuing interest in the furtherance of marine technology and its commitment to marine systems, particularly in the area of deep submergence. Dr. Craven, Chairman of the University of Hawaii's Marine Council and Professor of Ocean Engineering at the University is recognized for his extensive contributions to the field of marine technology and ocean engineering.

- **Bill Rainnie** now chairs the **Buoy Technology Committee**. Bill is with the NOAA Data Buoy Office in Bay St. Louis. Much of his spare time at present is being taken up by the planning of the 1983 Symposium on Buoy Technology (held jointly with the Gulf Coast Section).

- **Roger Cook** of the Harbor Branch Foundation is the new Chairman of the **Undersea Vehicles Committee**, replacing **Frank Busby**, who has earned a well-deserved rest.

Upcoming Events

–Call for Papers, *Oceans '83, Annual MTS/IEEE Conference and Exposition;* Hilton Hotel, San Francisco, California. Theme: "Effective Use of the Sea—An Update." Prospective authors are requested to submit a title, 250 word abstract, and an Oceans '83 Submittal Form by February 11, to: Oceans '83 Technical Program Chairman, P.O. Box 71030, Sunnyvale, CA 94086.

Epaulard, A Deep Ocean Exploration Vessel

By Dominique Girard
General Manager, GENAVIR
CNEXO
Paris, France

Dominique Girard since 1981 has been administrator of the oceanographic fleet of CNEXO, GENAVIR. He graduated from the Ecole Naval and the Institut National des Sciences et Techniques Nucleaires. He joined CNEXO in 1974, as program manager of underwater technology.

Any approach to acquiring manganese nodules goes through several steps which must be synchronized. Mainly, one has to explore the ocean bottom, recover nodules and then extract the interesting metals. The first step—exploration—is certainly the most advanced.

Several possible solutions have been studied and tested and some of them have become operational. *Epaulard* is one of these solutions; an original and—so far—the only free-swimming, acoustically-controlled vehicle, actually operated near the ocean bottom.

This article tells the story of the evolution of *Epaulard,* from 1976 to the present.

History

The Paris-based Centre pour L'Exploitation des Oceans (CNEXO) had been surveying the Pacific Ocean for several years prior to 1976, and had designed several types of nodule samplers, operating them on very large areas and on a loose grid.

Samples and photographs were taken every 50 nautical miles at first, followed by closer spacing. Approximate data were thus collected and provided approximate ideas of quality and quantity of nodules.

A denser coverage was needed. A statistical exploration of future claims has to be conducted on a smaller scale and provide answers to the conventional questions of where, how deep, how many, what assays, on what soil, and on what slope.

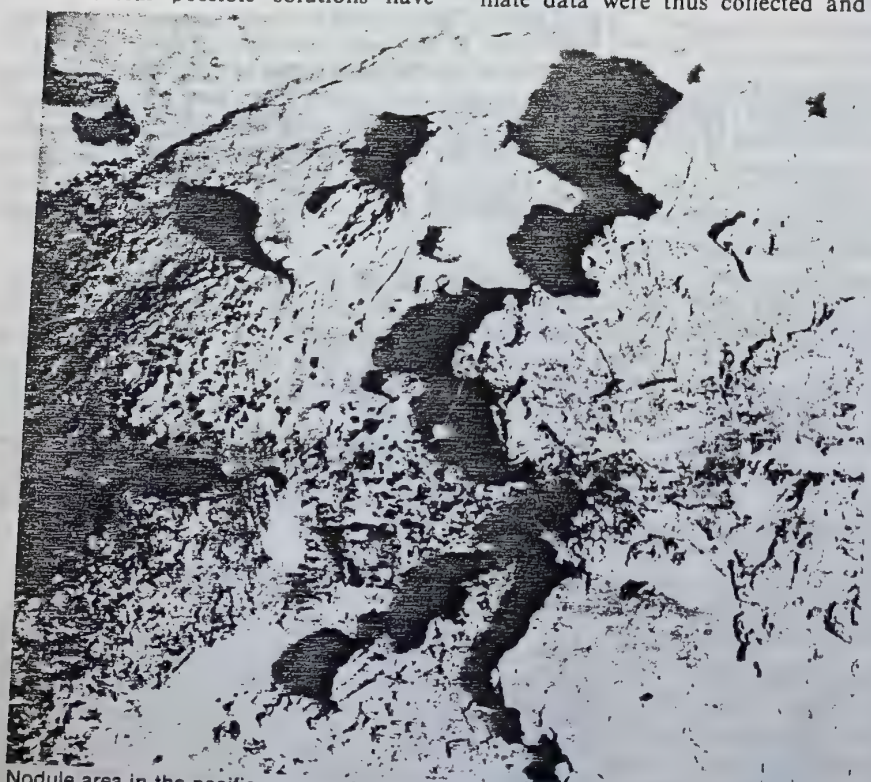
At that time other French scientists wanted more sophisticated equipment than the *Troika* (a towed sledge equipped with a camera, designed 20 years before by Jacques-Yves Cousteau's team). Others had used *Archimede* (11,000 meters) and were using *Cyana* (3000 meters) and *Alvin* (4000 meters). They dreamed of a deeper manned submersible, simpler and less expensive to operate than a 250-ton bathyscaphe.

Engineers from the Base Oceanologique pour la Mediterranee (BOM), the CNEXO research center in Toulon, had tentatively looked at P.A.P. vehicles, existing mine-hunting unmanned submersibles. Orders and TV images are exchanged between the vehicle and support ship throgh a 3 mm diameter cable. Such a cable could be a nuisance at 300 m depth, the engineers felt, but could it be eliminated in order to go deeper by relying on acoustics for controlling the fish?

Brainstorming over a fortnight was conducted on these three concepts: the deep manned submersible; deep towed vehicle and the free-swimming untethered vehicle. The criteria for decision included

- Total project cost
- Daily operating cost
- Price per square kilometer surveyed
- Time needed to provide an operational system
- Feasibility
- Innovative aspects.

The manned submersible was too expensive and would require too



Nodule area in the pacific, as seen from *Epaulard.*

long a construction time. The deep-tow was needed anyway for purposes other than for looking at nodules, so it would be built and would fit in the spread of nodule-exploration equipment.

The acoustically-controlled vehicle had much to recommend it—it was less expensive to build, could cover a larger area daily and could be conned more accurately. It was also a relatively new idea, and promoting new concepts was one of CNEXO's concerns. So the project was decided, budgeted, organized and christened *"Epaulard"* (French for Grampus of Killer Whale). The Grampus is suspected of being the most intelligent sea mammal. It was both an obvious choice and typical of French modesty to choose that name and then try to actually meet such expectations! The date now was March, 1976.

The first step was to prove the feasibility of acoustic control and of the guidance concept. A prototype control system was built, installed in a standard P.A.P. and tested at sea, using a minesweeper obligingly provided by the French Navy. By mid-November 1976 it had been proved that the acoustic control worked, even in the worst conditions—he horizontal acoustic channel in shallow waters. The automatic heading also functioned well.

The final specifications were then decided, the prime contractor chosen and bids sent out for subcontracts. The choice of the prime contractor and ship-plant was easy. ECA had already built 150 P.A.P. vehicles which sold world wide. This was a unique reference. C.I.T.-ALCATEL, manufacturer of the dynamic positioning (DP) system of the drilling ship *Petrel* and her three sister ships, was finally chosen for the acoustic link and SNPE/Euroshore provided the syntactic foam. So ECA was responsible for the fish and general engineering of the project, and CNEXO was responsible for the system including acoustics and electronics. A CNEXO-ECA joint team began working in March, 1977.

Although usual steps of such a project were followed, special care was given to hydrodynamics. The fish being autonomous, it was important to optimize stability and drag-coefficient. All the original specifications were met, costs were within 10% of budget, and in March, 1979 *Epaulard* tasted salt for its first time.

Although very confident, the project manager, Bernard Grandvaux and the project engineers Jean Louis Michel for CNEXO and Raoul Duranton for ECA decided to keep *Epaulard* on a leash for its first dives. The accuracy of the positioning system had been tested beforehand by laying the fish's transponder unit on the sea bed, circling above with the support ship and comparing the ship's position given by reference to the transponder and by a very accurate radio localization system.

The leash was cut finally in May 1979, at 2000 meters in the Mediterranean. In July *Epaulard* was shipped to the Bay of Biscay. A depth of 4200 meters was thus reached but some slight problems appeared in pressure-compensated, oil filled contactors, probably due to temperature conditions.

Modifications and improvements were made during autumn and winter 1979/1980 and tested. The operational team of four was trained and *Epaulard* finally transferred to GENAVIR, CNEXO's affiliate for operating oceanographic ships and equipment. The first exploration missions were conducted in 1981.

The objectives of *Epaulard*, decided in 1977, had been:

- To survey 30 to 50 kilometers of sea bottom per day, with a complete photographic coverage, 5 meters wide.
- To give a precise bathymetric profile.
- To navigate with an accuracy better than 2% of the water depth.
- To climb slopes of at least 20%.
- To operate in seas up to Sea State 4.

All objectives were met and some surpassed.

The general features and the operating procedures are as follows: length, 4 m; height, 2 m; width, 1.1 m; weight (in air), 2.9 Tons; speeds lm/s; 0.5 m/s, an overdrive and one speed astern; autonomy on the bottom, 6 to 8 hours; extra payload 40 kg.

Sensors and equipment include a vertical still camera (3000 to 5000 pictures, periods 5 to 10 seconds), a 200 joule flash, a tape recorder (time, course, altitude, depth, plus two available channels), an echo sounder, a depth meter and a thermometer.

The control system includes a teletransmission console and a tracking system (with an ultrashort base fitted at the extremity of a pole). A deck-cradle, 5 by 3.2 meters, includes a davit for dissassembling heavy components and a trolley for interchanging batteries. A standard 6.6 m container is equipped as a workshop for maintenance and pre-dive tests.

Once launched, *Epaulard* dives at a speed of .8 to .9 m/s (depending on the sea water density). A descent weight is jettisoned at an altitude of 50 meters and a guide rope then adjusts the altitude of the fish (usually 5 meters). A 48 volt lead-acid battery provides energy for the electronics and for a D.C. thruster. *Epaulard* navigates, reports to the support-ship, receives orders and collects data.

At the end of the dive an ascent weight is released. Several mechanisms can also trigger the release. After being recovered by the support ship, *Epaulard* is reconditioned in 45 minutes. This operation includes changing the batteries, the magnetic tape and the photographic film. The data are then mixed with the ship's own (navigation) and processed while the photographs are developed.

All the dives conducted in the last four years, either for trials or over the nodule zones, have proven the good matchup between the need and the result.

Epaulard is operated by a team of four to five people (depending on whether it makes one or two dives per day) on board any ocean-going support ship with a lift capability of 3 tons and deck space to house the cradle and the container, but needs no winch. It provides excellent photographs, precisely located. It may climb up slopes of 25% and climb down slopes of 30%, while follwing the bottom at an almost constant altitude. Contrary to a towed fish, the *Epaulard* will go where ordered. Since Autumn 1981, *Epaulard* can navigate using a long-base acoustic positioning system, the same as used for *Cyana*. The accuracy is then better than ten meters and *Epaulard* may, litteraly, comb the bottom and follow whatever ridge, valley or hill the user wants. A wide angle camera will allow a wider (9 meter) path to be photographed.

When *Epaulard* was designed, manganese nodule areas were described as "abyssal plains", as flat as the U.S. Midwest. As bathymetric knowledge increased it appeared that these areas rather looked like parts of New England with hills, light slopes and some stiff cliffs. The vehicle copes easily with such a morphology while a towed vehicle has a tendancy to bump, then take off for several minutes before stabilizing at its normal altitude.

There is some satisfaction for those who have conceived, designed, built, tried and operated a new tool, to find out that the goals were achieved within the scheduled time and budget, and that their creation is successfully used. But *Epaulard* has been tested for several uses other than nodule exploration, such as detailed mapping of a small area (50 to 100 acres a day), or measuring gamma radiation on a nuclear-waste dumping area. These uses all have the same basic need, operating simple sensors, at a constant altitude, where needed and with a good navigating accuracy.

Ongoing improvements include a vertical thruster and an acoustic image transmitting system. That will be another story.

International Conference on Underwater Operations Held in Paris

The first International Conference on Underwater Operations and Techniques was held in Paris, France, December 6-8, 1982. Over 250 persons representing 16 nations attended the three -day conference which was sponsored by Centre National pour Exploitation des Oceans (CNEXO) and organized by the ATMA (Association Technique Maritime et Aeronautique) and SAE (Societe des Amis de l'Ecole Nationale Superieure de l'Aeronautique et de l'Espace & de l'Ecole Nationale Superieure de Techniques Avancees).

Joseph Vadus, National Oceanic and Atmospheric Administration (NOAA), a member of the organizing committee, and a panelist, attended the conference and provided Sea Technology *with the following observations:*

The Conference was presided over by Pierre Willm, Institut Francais du Petrole (IFP), a prominent member of ATMA and one of the pioneers in France's ocean community. The conference Vice President was Dominique Girard, longtime member of the Marine Technology Society (MTS), and a former Captain in the French Navy, who now directs the CNEXO fleet of eleven ships.

Members of the organizing committee representing the U.S. included Frank Busby, R.F. Busby Associates; Andre Galerne, International Underwater Contractors (IUC), and Vadus.

The main objective in developing the technical program for the conference was to obtain quality papers from experts in the field and limit the number of papers so that they could be consecutively presented before all attendees. The program was developed into five areas:

- Safety and Regulations
- Underwater Operations
- Manned Submersibles
- Remotely Operated Vehicles (ROVs)
- Underwater Techniques.

The consensus of delegates was that the quality of papers was exceptionally high. Speakers and attendees read like a "Who's Who" in international undersea activities.

Based on the present state-of-the-art and current user needs, there appears to be a continued need for both manned and unmanned systems, divers, one- atmosphere diving systems, manned submersibles and remotely-operated vehicles. The trend is toward ROVs because of major improvements in remote viewing capability, manipulator dexterity and controllability, while deeper depth requirements and lower support costs also tend to favor such systems in general.

A luncheon meeting at the International Conference on Underwater Operations and Techniques, in the Le Grand Hotel in Paris.

However, the selection of a particular system, manned or unmanned, should always be based on user requirements and cost-effectiveness; i.e. being able to meet the mission requirement at the lowest cost without compromising safety. The selection process must consider the task to be performed, hazards, depth, support requirements, mobilization and demobilization costs and insurance.

Regarding regulations, there seems to be a desire to keep these at a minimum without sacrificing safety and standardization for emergencies. John Pritzlaff, Westinghouse, pointed out that there is a preference for using classification society rules and guidelines driven by insurance coverage and cost. The use of guidelines is worthwhile in that they are often revised and updated. However, once a regulation is in place, it is much more difficult to withdraw. Pritzlaff also pointed out the relatively good safety record of manned submersibles.

Pressure hulls for undersea vehicles constructed of composite materials such as carbon fibers were discussed with most reports indicating that the composites have good properties against stress and fatigue. Such materials are relatively impervious to sea water, are corrosion resistant, and have a very favorable strength-versus-weight ratio. Hulls constructed of composite materials are relatively easy to manufacture and automated industrial processes enable good quality control. However, there is continued need for development and improvements in quality control and cost reduction.

Energy sources for undersea vehicles was discussed by Perry Alers of U.S. Naval Research Lab. He indicated that greater demands for higher energy density systems are being brought about by increasing requirements for propulsion, maneverability, instrumentation, lighting and lighter weight systems. Lithium is being used in new primary battery

Speaker's table at the conference. Left to Right, Frank Busby, Busby Associates; Dominique Girard, CNEXO; Andre Galerne, IUC; Joseph Vadus, NOAA; and Jim McFarlane, International Submarine Engineering.

systems and heat sources for dynamic converters. Fuel cells of the type developed for spacecraft are being considered in addition to isotope sources with thermoelectric converters.

The primary concern in vehicle design is volume limitations—hence a greater need for higher energy density systems. These systems are costlier and presently custom-built.

Another paper discussed large capacity underwater energy storage systems. COMEX has been working with United Stirling to develop a 30 kw combustion engine burning methanol and oxygen which would have a power density on the order of 70 whrs/kg.

Undersea navigation techniques using short- and long-baseline systems and employing deep ocean transponders were also discussed. Doppler navigation systems using acoustic signals from the sea floor are showing great promise. Combined with precise gyros these systems can provide excellent dead reckoning navigation.

Roger Cook, Harbor Branch Foundation, Inc., described technology improvements made to the diver lockout submersibles. *Johnson-Sea-Link I* and *II*, especially in the area of externally-mounted tools. These improvements enabled reducing the amount of diver-lockout activity needed in Harbor Branch undersea applications.

Elliott Finkle, of NOAA's Undersea Project Office, described NOAA's four regional undersea research programs, at Santa Catalina on the U.S. west coast; Hawaii; Virgin Islands; and on the continental shelf, and the construction of a new temperate underwater habitat to be developed and operated by the University of Southern California.

In the area of manipulators, the consensus was that diver manipulative dexterity is still superior to manipulators. However, great strides in telemanipulation are bridging the gap. There are many undersea tasks that do not need sophisticated manipulation, so it is important to qualify the degree of control necessary. In some cases, simple go/no-go control with variable speed is adequate, while in more sophisticated handling, force feedback is necessary. Dual manipulators enable one arm to hold onto the work piece while the other performs the manipulative task.

As stereoscopic low light level color TV and manipulative technology improves, competition with manned systems becomes more formidable.

Art Markel of Reynolds Aluminum Co., Richmond, Va., discussed application of the *Aluminaut* for exploration of vast deposits of polymetallic sulphides. The *Aluminaut*—the world's only aluminum submarine—is capable of diving to almost 5000 meters and is being designed for sea-bottom investigations of these rich deposits.

Markel proposed equipping *Aluminaut* with side scan sonar and stereo color TV for survey operations, adding the capability of taking 20 to 30 meter cores and the addition of a 1.0 m diameter central viewport.

Pierre Willm presented a paper co-authored with H.G. Delauze of COMEX, describing plans by that French diving contractor to resurrect the 250-ton autonomous, self-propelled, undersea laboratory *Argyronete*. (In French, *Argyronete* means "sea spider.") The system employs a crew of six and is capable of operating at 600 meter water depths with limited diver lockout capability.

When first introduced, the *Argyronete* was one of the most advanced systems of its time and still offers unique capabilities. The hull is 3.7 meters in diameter and uses HY 100 steel. The power source will provide 1200 kwhrs capacity to enable 8 days of operating capability.

Argyronete is being developed as an alternative for subsea work with saturation diving capability. In order to increase work capability, the submarine will be capable of launching one or two ROVs.

Planned missions include non-destructive testing near platforms using divers and/or ROVs; and under-ice operations for bathymetric, seismic and coring missions. Other plans involve using it as a test bed for technologies including the testing of the Sterling engine developed by COMEX and United Sterling for main propulsion.

An advanced manned submersible, *SM97*, being developed by CNEXO, was also previewed. *SM97*, i.e., *Sous Marine (Undersea) Vehicle 97*, is designed to operate to 6000 meters. With this depth rating, the submersible is capable of traversing 97% of the world's ocean floor, hence the number 97.

The optimistic schedule is for test dives in 1984; joint operations with Japan in the Japan Trench in 1985 and readiness for general use in 1986.

On the final day of the conference, the French Minister of the Sea M.L. Le Pensec addressed the body describing the great opportunities in ocean exploitation. He took this opportunity to announce a major reorganization, the merging of CNEXO and ISTPM (Scientific and Technical Institute for Marine Fisheries) into a new organization called IFRE-MER, Institut Francais Reserche Exploitation—MER.

This would result in merging about 600 people from CNEXO with 500 from ISTPM for a total of 1100 with the addition of 11 CNEXO ships and crew of about 300. Main subdivisions of the new organization are Ocean Programs, Scientific Research and Industrial (technology) Programs.

In view of the success of the conference, the principals of the organizing committee have indicated plans to conduct the second international conference within two to three years. Proceedings were published and are available through Editions Technip, 27, rue Ginoux, 75737 Paris, CEDEX 15, France.

Harbor Branch Vessels Investigate Offshore Banks, Submarine Canyons and Tilefish

Susan van Hoek
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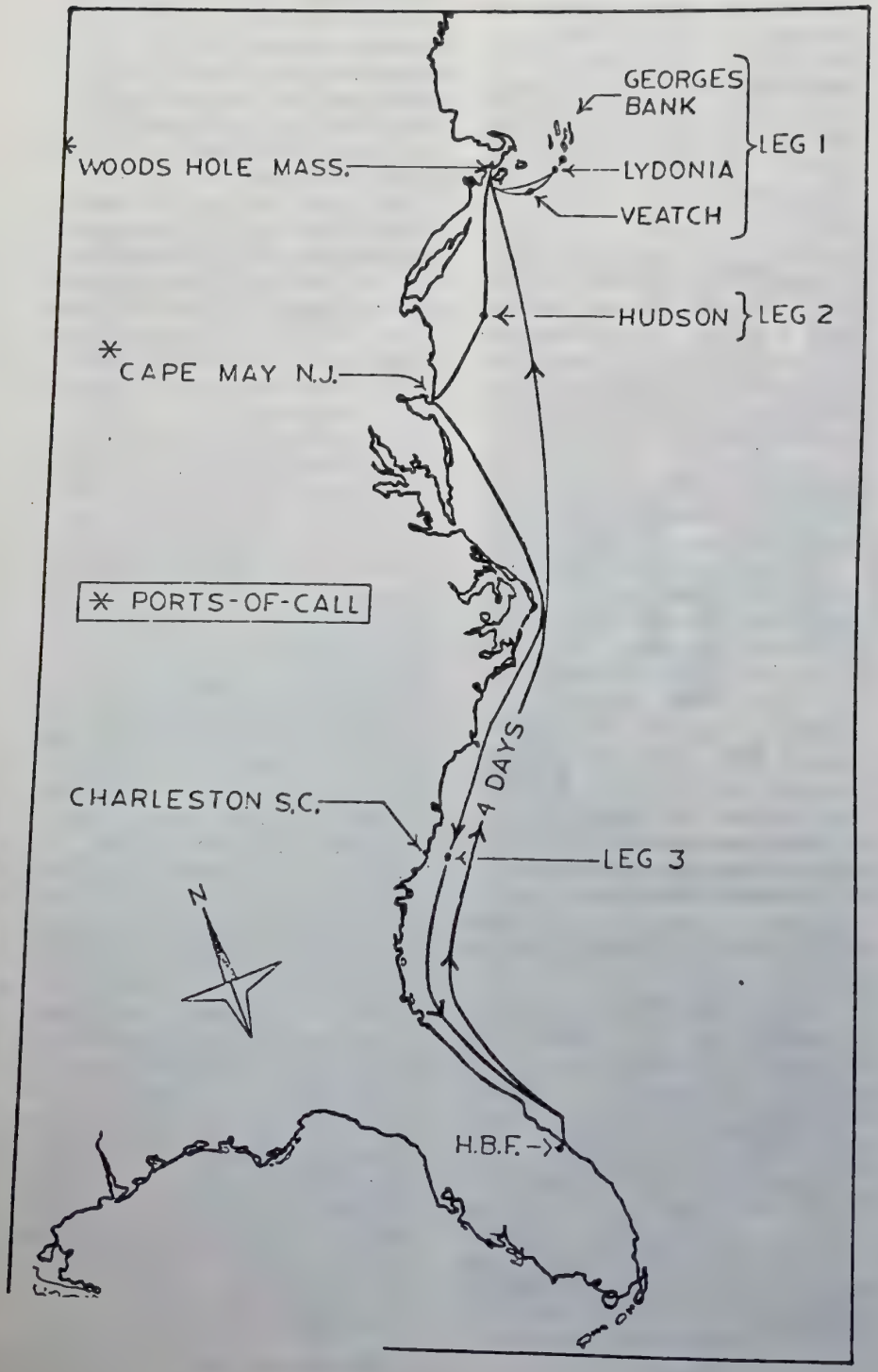

A forty-day cruise off the U.S. east coast by the Harbor Branch Foundation research vessel *Johnson* provided five marine science agencies with information pertaining to tilefish, fisheries management, and the possible effects of offshore drilling on marine life.

At depths ranging from 77 m to 497 m, the Link Port, Fla.-based Harbor Branch submersible, *Johnson-Sea-Link I*, provided an underwater platform for the investigations carried out during a three leg mission in July and August.

Leg I, conducted for NOAA's National Marine Fisheries Service (NMFS) and the U.S. Geological Survey (USGS), was to assess the potential impact of deep sea drilling on the Georges Bank fishery off New England. Leg II, a cooperative effort between Harbor Branch, Rutgers University and the USGS, was to examine tilefish habitats near Hudson Canyon, off the coast of New Jersey. Leg III, cost-shared by Harbor Branch and NMFS, working with the South Carolina Marine Resources Research Institute (SCMRRI), took place on offshore banks east of Charleston, S.C.

During the first leg, devoted to NOAA's ongoing "Ocean Pulse" project, Dr. Richard Cooper (NMFS) and Dr. Page Valentine (USGS) revisited monitoring sites previously established with Harbor Branch vessels and crews. For the third consecutive year the scientists worked in unison with Harbor Branch personnel, developing increasingly efficient usage of the ship and submersible capabilities to gather data on vital underwater resources.

In cooperation with Harbor Branch operations directors Roger Cook and Jeff Prentice, the scientists were able to utilize the submersible to

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ok directly at this nation's richest shery. Underwater cameras have provided a bank of over 22,000 color photographs. The two groups photographed, sampled, and video taped the ocean floor and its population of such animals as tilefish, lobster, crab, and sea scallops, looking at the fishery in relation to drilling at Georges Bank and its associated submarine canyons.

Cooper, speaking for NMFS, stated that long-term studies with Harbor Branch and *Johnson-Sea-Link* have enabled scientists to "really get to know" the unique fishery habitats and distinctive ocean floor characteristics. He noted that the sub crew frequently witnessed dramatic changes in the bottom terrain, as they glided from boulder fields to wave-rippled sand, and across mud plains covered with "forests" of anemones.

From the vantage point of the submersible, the investigators were able to observe behavior as well as habitat, and discovered that fishery animals, much like humans, tend to orient themselves to their distinctive environments.

The scientists feel that annual Ocean Pulse research is beginning to supply accurate, reproducible information that shows results. One such result, in a statement recently made by Cooper, is that after nearly two years of drilling investigations reveal "no indication of any impact of gas and oil exploration drilling on the fisheries or their habitats today." However, extensive data gathered for this project will serve as a baseline for comparison over the next 8 to 10 years.

Dr. Churchill Grimes from Rutgers and Dr. David Twichell from USGS participated in Leg II of the mission with Harbor Branch Managing Director Dr. Robert Jones. Underwater studies were carried out to collect fishery data on the commercially important Atlantic golden tilefish (*Lopholatilus chamaeleonticeps*) which appears to be suffering a population decline at this time.

The fish and their burrows were mapped at three specific locations around Hudson Canyon where the scientists are attempting to compare year-to-year variations in tilefish abundance. The submersible was used to ground-truth tilefish habitats investigated with side scan sonar. Researchers hope to be able to identify tilefish burrows or bottom types associated with such burrows. Video tapes and twenty-four hour time-lapse photos also documented the behavior of the popular food fish that appear to live in "social" communities.

By utilizing a newly-developed net designed specifically for tilefish by Harbor Branch, investigators were able to capture live samples for analysis by the Rutgers team. Sub-bottom profile surveys also allowed scientists to examine the underlying sediments and Pleistocene clay where the burrowing animals dwell.

As observed in previous years, the fish kept the clay surface around their burrows "swept" clean of sediment, and they were again seen hovering above the burrows where they would dive headfirst when approached by the sub. An unusually rough bottom terrain was attributed, in part, to the burrowing fish. Jones said that the ability of many generations of tilefish (and other associated organisms that burrow in clay) to sculpture the sea floor was of great interest to all of the scientists on the mission.

Harbor Branch Vehicle *CORD II* Tested Off Bahamas

Cord II, an unmanned, remotely-operated submersible built by the Harbor Branch Foundation, Inc., Fort Pierce, Fla., recently underwent sea trials off West End, Grand Bahama Island. *Cord II*, the Cabled Observation Rescue Device, was designed by Harbor Branch to operate in the Gulf Stream in currents up to 5 knots at depths to 914 m, according to David Clayton, Harbor Branch Research and Development Manager.

During the week-long Bahamas operation the vehicle successfully performed a series of prolonged underwater tasks to depths of 610 m, in currents exceeding 2.0 knots, according to Clayton.

The vehicle is operated from a van located on the deck of the 30 m Harbor Branch vessel *Sea Diver*. Commands and responses are transmitted over an armored coaxial cable to control the submersible's TV, camera, sonar, six-function manipulator and cable cutter.

Continental Shelf studies off Charleston in Leg III were of special significance to observers from the sub, as well as those watching from the video screen aboard ship, because they were the first humans to see the ocean floor firsthand in this relatively new fishing ground. Blueline tilefish were found to be living among unusual rock formations consisting of large broken slabs, rubble and boulders, in complex underwater structures. The mottled brown, black and gold colored rock samples were later said to be a type of recemented limestone by Harbor Branch Marine Geologist Dr. Charles Hoskin. The rugged area, characterized by steep, layered construction, was said by Jones to be one of the roughest continental shelf habitats he had every had the opportunity to dive on.

During this leg the NMFS Chief Scientists Dr. Walter Nelson and Dr. Elmer Gutherz, along with Dr. Charles Barans and Dr. Charles Wenner of SCMRRI, and crews aboard South Carolina's *R/V Oregon*, tagged fish for recapture and for submersible observations on later missions. Fish habitats were also studied closely, as was the terrain itself. A variety of other fish species, including several types of commercially important grouper, dominated by the Snowy Grouper (*Epinephelus niveatus*), were found to be living in the area and recorded by the scientists. In addition, fish population measurements were made to determine how many pounds per acre of a given species could be found in the fishery.

Johnson-Sea-Link I was also used in gear evaluation studies involving two longline fishing techniques. One method that seemed to prove effective was the use of a long bottom line, anchored at either end, interspersed with vertical poles bearing hooks and bait. This technique is designed to reduce gear hangups and to keep the bait off the bottom where, Jones said, crabs and other predators are likely to "pile all over it."

Researchers from the combined organizations feel their Leg III investigations have provided enough ecological and other data to make a significant contribution to the development of the new fishery.

"An exciting highlight of the lengthy cruise was the opportunity for researchers to compare these rocky offshore banks with the ecology of their coral reef counterparts off the coast of Florida," Jones said. "Different species of animals dwelling far apart and under different conditions are 'making their livings' in basically the same ways."

As investigators from the five organizations uncover facts by further laboratory analysis, data gathered from this summer's extended mission should bring new light to bear on our understanding of several of the nation's major east coast fisheries.

Harbor Branch Foundation, Inc. is a not-for-profit corporation established primarily for research in the marine sciences and for the development of tools and systems for underwater oceanographic research.

Slack in umbilical blamed for loss of bell off Labrador

Development of slack in the umbilical as it was payed out from the winch drum resulted in the loss of a bell in 197m of water off Labrador last July, according to a Canadian Petroleum Directorate report.

The umbilical was severed on board the drillship *Pelerin* at 1521 hours on 16 July 1982, sending an MOB 1000 (Manned Observation Bell) to the seabed. *Pelerin* was drilling in the Northern Labrador Sea on the Pothurst P-19 well. Both bell and occupants were safely recovered at 0146 hours the following day.

Pelerin is owned by Helmer Staubo and was contracted out to Petro-Canada, operators of the well. The MOB 1000 was operated by Hydrospace Marine Services also under contract to Petro-Canada. The bell is a two-man, one atmosphere observation bell with an umbilical which provides power, communication and in-water lift. All other life support systems are self-contained with enough air and food for 72 plus hours. A heave compensator connected to a series of pullies maintains constant tension and takes up any slack in the bell's umbilical.

The bell was mobilised to dive and observe cement returns on the sea floor during the cementing of the 762mm (30in) casing. Petro-Canada requested that one of its drilling engineers be a participant in the dive.

After a pre-dive safety meeting a number of safety precautions were taken. A wire grommet and safety sling were attached to the MOB, lifting slings and a personnel basket for the crane, fishing tool and underwater camera were placed on standby, and the ship was made ready to release from bottom. Rescue procedures discussed included the need for the bell to remain on the bottom for three hours 15 minutes if communications were lost, to give time for rescue attempts with drill string fishing tool. If this failed after three hours the ship would move up current and 15 minutes later the bell was to drop her weights. *Balder Cabot* with two Mantis manned submersibles was available locally. Weather was good.

Ten minutes after the moonpool doors opened, after the safety strap had been attached, the ram was opened and the dive supervisor began deployment of the MOB's main umbilical. The pilot began thrusting downwards and rotating the MOB to face the drill string.

A loop formed in the umbilical at the winder drum. Observing this the compensator operator shouted 'stop the winch'. When the winch stopped it was noticed that the umbilical loop had jumped off the winch drum and onto the shaft cover. It may also have caught in the worm gear under the drum.

As the MOB descended, taking in the slack, the umbilical was brought into tension across the drum lip and severed. The MOB then fell towards the seabed losing main power and communications, the extended position of the manipulator arm causing a slight forward list.

Emergency power was restored automatically to the communication and chemical scrubbing systems. The MOB hit the seafloor with a mild impact which did not appear to damage the subsystems. One negative buoyancy dropweight rack was forced against the ballast tank, bending the inboard portion of the rack assembly and pressing the drop weights firmly against the outboard angle supports of the rack. The MOB had come to rest in 250mm of very soft mud, with a slight forward list. The pilot and the drilling engineer immediately donned survival suits.

An undersea acoustic teletransducer was lowered into the water. Voice communications could not be re-established immediately, but morse code signals were sent and received by the MOB occupants. An onboard sheet of emergency morse phrases enabled the pilot to translate the morse signals.

Balder Cabot was requested to steam at full speed to the site. A helicopter was dispatched to *Pelerin* and an Air King fixed-wing aircraft was placed on standby. A tv camera was rigged to the drillstring. The cementing procedure was stopped and the hole displaced with seawater.

Voice communications were established with the MOB. All occupants were reported unhurt and the MOB was upright. Casing was pulled out of the hole and hung in the moonpool. Petro-Canada and Staubo met and agreed to move the ship up current to allow the MOB free ascent.

The pilot attempted to jettison the umbilical. The severing device operated properly, but the flotation device was caught in either the emergency lifting sling or the bell's top works so that neither collar nor umbilical floated free. The pilot then attempted to jettison the drop weights. The cable cutting device worked and the port side weights were released.

The starboard side weights however were firmly jammed in the rack and would not fall clear. The occupants attempted to rock the bell clear of the mud, but silt disturbance by the MOB's bottom ring indicated to the pilot that the mud was not holding the MOB down.

The pilot then attempted to jettison the manipulator but as it was not fully extended, it failed to clear the bell. Another attempt to jettison the umbilical and drop weights also failed. The ballast tanks had been fully charged and with one set of drop weights still in the rack, the MOB was still negatively buoyant and unable to ascend to the surface. The pilot was advised to abort further attempts at free ascent and be ready for recovery by a Mantis.

The dive supervisor and two divers from *Pelerin* boarded *Balder Cabot* with through-water communications equipment and diving gear. Eight kHz through-water voice communications were re-established with the MOB, as *Balder Cabot* dynamically positioned itself 30m and 313° upcurrent from the bell. *Pelerin* was 500m upcurrent. A large ice floe had been advancing slowly from the north east but remained stationary six or seven kilometres away during this operation.

After deployment of Mantis 8 through the *Balder Cabot* moonpool, the submersible pilot reported that he had picked up the MOB's 37.5 kHz pinger but visibility was poor because of silty bottom conditions in a half knot current. Mantis 8 located the MOB's lights while conducting a pinger sweep.

The Mantis then attempted to pull the umbilical free, without success. An attempt to free the flotation collar also failed. *Balder Cabot* manoeuvred itself over the MOB and lowered a lifting cable and shot weight to within 5m of Mantis 8. Mantis recovered the hook and attached it to the frame of the MOB.

The end of the recovery line became entangled in one of the Mantis' four thrusters. Attempts were made to unfoul the line without success. Since the Mantis still had ample manoeuvrability with the remaining three thrusters, and there was no immediate danger, it was decided to continue with the rescue operation, and lift both Mantis and bell simultaneously.

Both were lifted to just under 16m. A diver entered the water to secure a wire rope to the MOB. He also succeeded in freeing the flotation collar. The MOB was lowered to 30m to take up slack on the recovery line and the Mantis was released. Using a one tonne winch the MOB was lifted in 7.6m increments, to allow the lines to be rigged at each step.

After a total recovery time of 10 hours 25 minutes, the MOB occupants were medically examined on board *Pelerin* and declared fit.

The report of the Canadian Petroleum Directorate concluded that the incident was directly caused by the development of slack in the umbilical as it was payed out from the winch drum. This was due to the umbilical

being deployed too rapidly and the heave compensator being pressurised improperly, thereby rendering it incapable of taking up slack. Slower deployment of the umbilical or faster thrusting of the bell might have prevented the development of slack. Proper operation of the heave compensator might also have prevented excessive slack from forming in the umbilical.

The report added that a number of safety devices which form an integral part of the MOB system failed to function properly during the recovery operation.

It was apparent that Petro-Canada, Staubo and Hydrospace Marine Services were adequately prepared for this emergency. Diving personnel of both the MOB and Mantis were also adequately trained. The report also found that the crew of *Balder Cabot* exercised sound judgement and due caution throughout the recovery operation.

The report's recommendations related only to the incident under investigation and made no attempt to cover all possible lost bell scenarios. They were:

- A more comprehensive training programme should be instituted to give operations personnel 'hands-on' experience in all aspects of MOB operations. The present training arrangement permitted training dives only to the bottom of the cursor. It did not permit the rams to open with the MOB leaving the cursor, the point at which this incident occured.
- The gauges of the heave compensator should be marked to indicate their normal operating position.
- A removable guard or cover should be placed around the winch drum to prevent a loop from leaving the drum.
- The design of the MOB drop weights should be examined to identify modifications which could prevent malfunctions should a similar event occur in the future.
- The configuration of the umbilical flotation collar should be modified to preclude its jamming in the MOB top works during deployment.
- The MOB should be capable of blowing ballast under emergency power. This could be done by making the ballasting pump system operable from onboard battery power or, by installing compressed air tanks and connecting them to the ballast system.

'Project WASP' yields new research data

Researchers from the University of California, Santa Barbara (UCSB) recently carried out "Project WASP" in the Santa Barbara Channel, using an Oceaneering WASP Atmospheric Diving Suit to observe, collect and photograph specimens underwater.

Headed by UCSB biologists Bruce Robison and Alice Alldredge, Project WASP was conducted from the research vessel, "New Horizon", operated by the Scripps Institution of Oceanography. The vessel was anchored approximately 10 miles from UCSB's seashore campus.

The researchers had equalled the WASP's record dive of 1,780 feet made in the Gulf of Mexico shortly into the project. Robison reported he was able to capture fish using a combination of stealth and a burst of speed from WASP's thrusters.

The researchers said they collected what they believe to be new species of marine organisms, as well as darting fish — captured in tube-like devices, as they are too fragile for nets — and "marine snow", particulate matter inhabited by microorganisms which play a crucial role in the recycling of nutrients in the deep sea.

"WASP may revolutionize our perception of deep-water communities," noted Robison, a specialist in deep-sea fish and the ocean's nutrient transfer system.

New studies on the behavior of marine animals made possible through use of the WASP included feeding, mating, activity levels, interaction between species and other general marine activity.

"It is as if we had spent 100 years studying the forest from hovering helicopters — then suddenly we're allowed to land and walk freely among the trees," observed Ms. Alldredge.

The pressure-sealed suit, which keeps the operator inside at the same pressure as if he or she were on the surface, is equipped with thrusters which allow the researchers to move in any direction, or to hover in one spot for a prolonged period. Wearing night-vision goggles, the researchers are able to flood the surrounding water with red light and observe the marine animals, which are sensitive only to blue-green light.

The operator is free to perform photography and video taping and talk to people on the vessel through the communications tether.

The researchers are the first to use the WASP suit for these purposes. A crew from Oceaneering worked with the scientists throughout the 25-day expedition.

The researchers say it will take weeks for them to assess the data and specimens collected during the project, which was funded largely by the National Science Foundation.

Now the Navy Submersible Pilots Have an Emblem

Chest emblems for specialties in the U.S. military services are of long standing. In the U.S. Navy and the U.S. Army Air Corps, aviators' wings are well known, gold for the Navy, silver for what is now the U.S. Air Force.

Not as well-known but of equally long standing are the Navy submariners' dolphins. Of more recent origin is the surface warfare pin, featuring waves, crossed swords and the bow of a ship.

Now there is another. Deep submergence officers, almost all of them already wearing submariners' dolphins are being designated submersible pilots. Their pin has the *Trieste I* world depth record holding submersible as the center of the display.

))) **Lake Champlain Yields More Shipwrecks.** One of the major "sea" battles, of the U.S. War of 1812 with Great Britain, the Battle of Plattsburg, took place far from an ocean. It was fought on Lake Champlain in northern New York state near Canada. After the battle the U.S. fleet sailed to the lake's southern end to await action, which never came. The fleet was decommissioned at the war's end, fell into disrepair and the ships sank years later. Some years ago one wreck was raised, preserved and put on display in the Smithsonian Institution's Museum of American History in Washington. Now divers of the Champlain Maritime Society have uncovered 20 more wrecks, including three gunboats. Two are tentatively identified as the *Eagle* and the *Linnet*, while the third remains unidentified. Future plans regarding the wrecks haven't jelled.

Review & Forecast

Undersea Vehicles

By Frank Busby
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In spite of a general slowdown in offshore drilling activities, the undersea vehicle community continues to expand. But some of its members—particularly the untethered, one-atmosphere, manned submersible group—have fallen upon hard times. This is not so much from their inability to perform as from the advancement and acceptance of competing technologies, such as Remotely Operated Vehicles (ROVs), and one-man, tethered submersibles and Atmospheric Diving Suits (ADSs).

Even the diver, still the supreme intervention technique of the offshore industry, can, if he listens, hear footsteps. Santa Fe Diving and Construction, for example, recently changed its name to Santa Fe Underwater Services to reflect its ROV inventory which will include 5 RCV-225s and 5 RCV-150s by the end of 1982. While such sorting out and matching of capabilities to requirements progresses, supporting technological developments in the areas of manipulation, power, tools and instruments and deployment techniques are also receiving attention.

In many respects the major underwater service companies, although they might be loathe to admit it, are not unlike the members of a spooked cattle herd. In the 1960s they thundered off to the call of saturation diving; then paused and wheeled briefly to manned submersibles, at which point the herd divided and some of its members galloped toward untethered vehicles, ADSs, observation/work bells or lockout vehicles. In quick succession they bolted toward welding/repair habitats, one-man tethered submersibles and then, more recently, to ROVs. Here they split forces again; lowered their horns and pawed the ground in a brave gesture of defiance. Hydro Products spooked some; Ametek Straza galvanized others and International Submarine Engineering panicked the remainder, while a few charged off to develop their own creations.

Today the herd has reassembled and nervously grazes—encircled by saturation diving systems; manned submersibles; habitats; ROVs and a variety of hybrid vehicles combining two or more of these capabilities and with one eye on the forage and one eye looking through the cracks of technology. One can only speculate on the type of whistle or hoot that will send the herd thundering off in the direction of a new idea. But this is the essence of a competitive market, and since the potential customer provides little evidence toward needed future developments, what else can the potential contractor do?

While the foregoing analogy is not accurate in all instances, it is not too far off the mark. A brief review of the current status of undersea vehicles and developmental projects underway serves to add a sense of credibility to this analogy.

Manned Submersibles

The manned submersible arena is holding its own fairly well. On the debit side is British Oceanics Ltd., who is trying to sell off a major portion of the 19 one-atmosphere and lockout vehicles they currently own. On the credit side are a number of new vehicles recently built by Comex and Perry Oceanographics. The one-man MANTIS has reached a total of 17 vehicles and their manufacturers, the OSEL Group, have produced a recent hybrid called MANTIS DUPLUS which can operate either manned or unmanned. The Atmospheric Diving Suits, WASP and SPIDER are usefully employed as are the observation/work bells ARMs, MOB and OMB.

One project, in limbo for the past 10 years, has been resumed. This is the French submersible *Argyronete*, a lockout vehicle manned by a crew of 6 and 4 divers and capable of operating originally to 600 m. Comex and United Stirling of Sweden are jointly engaged in development of an external combustion closed-cycle engine which will generate 94.5 KW. Whether or not the latter project will result in a power source for *Argyronete* has not been stated.

The West German firm Bruker Meerestechnik GmbH has completed hull fabrication for the 50 ton, 200 m depth submersible *Sea Horse II*. It will carry a crew of 4 to 6 and have a subsurface range of 80 to 100 nautical miles, plus an additional 200 to 300 nm on the surface. Delivery is scheduled for the summer of 1983 to an unidentified customer. Application of *Sea Horse II* is multifold and includes research, pipeline route surveys and inspection, subsea patrols and security duties.

The Swedish shipbuilding firm of Kockums and the Norwegian Underwater Institute are jointly developing a 900 ton, mobile habitat called *Diving Mosquito*. It will carry a crew of 8 to 12 and 16 divers to depths of 350 m. The objective of this project is to provide undersea work services North of the 62° line and in the Arctic. Testing of *Diving Mosquito* will begin in Bergen in 1983.

In short, the manned submersible field is difficult to summarize. While there is a great deal of activity in some areas with certain types of tethered one-man vehicles, ADSs, Observation/Work bells and very large submersible and habitats, there is a dearth of activity in the "conventional" one-atmosphere vehicle field. Whether or not this type of vehicle will slip quietly back into obscurity, as it did in the late sixties, or resurge again is speculative.

Remotely Operated Vehicles

ROVs are still the growth industry in the undersea vehicle market. In 1982, orders for—and construction of—vehicles amounted to 111 units. The major producers of industrial vehicles are International Submarine Engineering Ltd., Hydro Products and Ametek-Straza. The military field continues to be dominated by the French firm Societe Eca with their PAR 104 mine neutralization vehicle. The variety of choices in the ROV field is almost overwhelming, with 35 manufacturers (industrial and government) producing 52 different vehicle types. Almost daily a new manufacturer emerges with a new entry into the ROV field.

One of the more recent entries was the British company Slingsby Engineering who received a "multi-

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million" pound order from Stolt-Nielson (already the owner of 12 ROVs) for a new ROV called *Solo*. The vehicle is rated for operation to depths of 1350 m with an option to 2150 m. *Solo's* unique features include a larger payload than other ROVs and the utilization of a fiber optic link in the umbilical cable for data transmission. The first vehicle will be delivered in 1983, Stolt-Neilsen has options on the first five production models.

One aspect of ROVs which is an advantage in the currently depressed drilling market is that they are infrequently used in this exploratory phase. Their work primarily involves inspection maintenance and monitoring of production platforms and pipelines. Consequently, they should not feel the impact of the slowdown as severely as will those intervention techniques which primarily support exploratory drilling.

A further potential incursion into the diver's territory was made in a joint venture by Perry Oceanographics, JERED and Shell Oil Company. Using a RECON IV ROV, they successfully demonstrated the vehicle's ability to transport and attach sacrificial anodes, weighing several hundred pounds, to a steel structure. Anode replacement has long been the diver's domain, but the ROV is flexing muscles in this area as well.

Another domain of the diver, pipeline repair, is being invaded by a COMEX ROV system. The Deep Sea Repair System is designed to conduct initial cutting, preparation and welding of a pipeline to depths between 300 and 1000 m completely by remotely controlled components. Testing began this year and will continue until the prototype performs satisfactorily.

One bright spot in the ROV field, the untethered or autonomous vehicle, is still languishing in the backwaters of uncertain funding. Virtually all of these vehicles are dependent upon government funds for development. Since there is a chronic shortage of government R&D funding, progress has not been as rapid as the autonomous vehicle advocates might wish. For industrial application of this technology the impetus has come from the Minerals Management Service of the Department of the Interior. Funding from MMS to the University of New Hampshire and the Naval Ocean Systems Center, San Diego has set the pace for development of autonomous ROVs for application in structure and pipeline inspection. No other programs, except for the French firm Thompson CSF, are directed toward inspection goals. Remaining U.S. Autonomous vehicle projects are military oriented.

Overall the undersea vehicle community is enjoying an era of prosperity. When some participants have fallen by the way side, others have risen to take their place. While the future appears excellent, the crapshoot will continue and probably accelerate regarding which technology, manned submersible, ROVs, ADSs, mobile habitats, large submersibles, deep submersibles, autonomous vehicles or hybrids of varying capabilities to back.

Forecast: more of the same. ◘

Perry PC-1805 Submersible Delivered For North Sea Operations

Perry Oceanographics, Inc. of Riviera Beach, Fla., recently delivered the PC-1805 manned submersible for charter in the North Sea by Shell/Esso. The four-man diver lock-out submersible is externally rated to 300 meters (984 FSW). The diver lock-out compartment is designed for internal pressurization to 200 meters (656 FSW).

The Perry PC-1805 is the fifth and largest submersible in the PC-18 series.

The PC-1805 will be deployed from the multifunctional service vessel Stadive, now under construction in Finland and to be chartered by Shell/Esso, for underwater survey and pipeline maintenance work in the northern North Sea.

The submersible is over 25 feet long, 8.5 feet high, and weighs 16 tons at neutral bouyancy. The normal bottom time is expected to be eight hours, which is reduced to four hours when the onboard survey equipment is in use. The PC-1805 is equipped with two six-function manipulator arms. Side scan sonar allows hor- other subsea objects, which aids in pipeline tracking and plotting.

The PC-1805 communications system includes a VHF radio and underwater telephone system. A pinger transmitter allows tracking by a rescue vessel in emergency situations.

The vehicle is equipped with a sophisticated television system including a black-and-white, low light level camera, two color cameras, and two color monitors, as well as a 70-mm still camera and strobe. During video recording, the control unit collects data such as heading, depth, and echo-sounder information, and annotates the details onto the video monitor. The operator can input additional data from a portable keyboard.

For further information on Perry Oceanographic's subsea vehicles and systems,

Robertson Introduces Subsea Gyrocompass —Literature Available

Robertson A/S Radio Elektro of Egersund, Norway, has begun production of the Robertson Subsea Gyrocompass (RSG) following extensive testing of prototypes.

Literature is available describing the RSG which is based on the SKR-80 gyrocompass, a highly successful, time-tested instrument. In designing the subsea gyrocompass, Robertson had to construct the standard unit's subassemblies for use in a pressure chamber or in one-atmosphere cover, and a system that would be capable of operating at 1,000 meter depths with either internal or external submersible mounting.

For full information on the new RSG from Robertson,

NOAA"S REGIONAL UNDERSEA RESEARCH PROGRAM

Introduction

The National Oceanic and Atmospheric Administration's (NOAA) Office of Undersea Research is expanding its support of regional undersea research activities to provide a wider variety of opportunities, geographic locations, and facilities for use by marine scientists. In addition to continued sponsorship of the Caribbean Regional Hydrolab Program in St. Croix, which is operated by Fairleigh Dickinson's West Indies Laboratory, NOAA has entered into cooperative agreements to implement new programs with the Universities of Hawaii, North Carolina at Wilmington, and Southern California. This program expansion offers new undersea research opportunities in tropical island and coral reef waters, in a mid-Pacific archipelago, along the Southeastern United States continental shelf, and in a temperate water kelp biome. The undersea facilities which are uniquely tailored to their operating sites are made available to participating scientists at no cost.

Objectives

The goal of these cooperative regional undersea research programs is to support NOAA in fulfilling its mandated ocean responsibilities for managing and protecting living marine resources and their habitats, monitoring and conducting research in marine pollution, and managing marine sanctuaries. Specific objectives are to:

(1) Acquire basic scientific information about the marine ecology and environments in U.S. coastal waters.

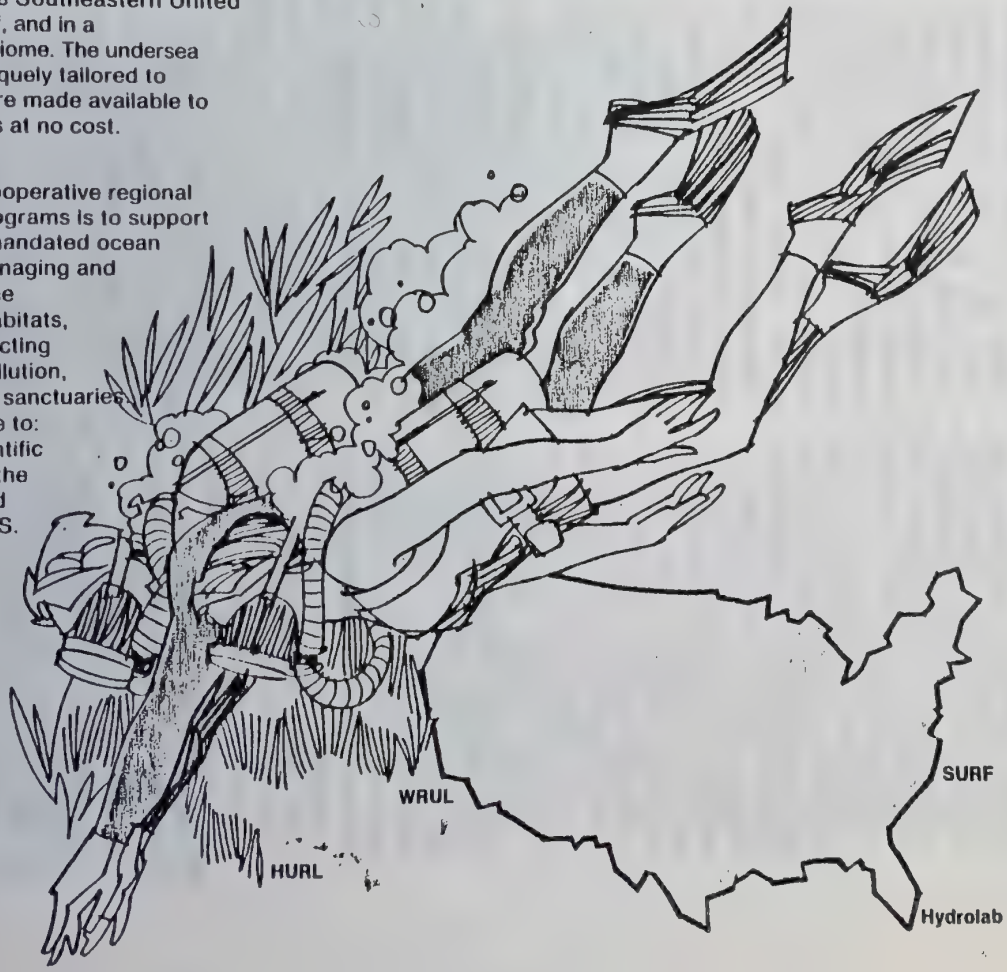
(2) Broaden support of research efforts requiring advanced undersea facilities and capabilities.

(3) Enhance ability of researchers to successfully complete selected undersea tasks and to extend classical land based laboratory scientific methods and capabilities to the seafloor.

(4) Ensure continuity of effort and long-range funding for otherwise infeasible *in-situ* research efforts.

(5) Provide training and facilities to develop a cadre of scientific personnel proficient in the use of underwater laboratory facilities and advanced undersea research techniques.

(6) Strengthen academic relations with NOAA in accomplishing marine research.



Each program will conform to NOAA regulations with respect to safety and training, diving and mission operations, and facility classification and certification requirements. Proposals for missions using any of the facilities can be sent either to the NOAA Office of Undersea Research or to the program principal investigator. Proposals submitted will be evaluated by the peer review process, and if rated highly will be scheduled for mission time allocation.

Contacts

Additional information is available from:

NOAA Office of Undersea Research
National Oceanic and Atmospheric Administration
6010 Executive Boulevard
Rockville, Maryland 20852
(301) 443-8391

Hawaii

Hawaii Undersea Research Laboratory (HURL)
University of Hawaii
2540 Dole Street, Hol-401
Honolulu, Hawaii 96822
(808) 948-8723

University of Southern California

Western Regional Undersea Laboratory (WRUL)
Catalina Marine Science Center
P.O. Box 398
Avalon, California 90704
(213) 743-4113

University of North Carolina

Southeastern Undersea Research Facility (SURF)
University of North Carolina (Wilmington)
601 South College Road
Wilmington, North Carolina 28403
(919) 791-4330

St. Croix

Caribbean Regional Hydrolab Program
West Indies Lab
P.O. Annex Box 4010
Christiansted, St. Croix
U.S. Virgin Islands 00820
(809) 773-3339

Revised September 1982

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

Caribbean Regional Hydrolab Program

The Caribbean Regional Hydrolab Program, operated by the West Indies Laboratory of Fairleigh Dickinson University, is located on St. Croix, U.S. Virgin Islands. Research operations began in 1978. HYDROLAB, a seafloor habitat in 50 feet of water located at the head of a submarine canyon one-half mile off the north central coast of the island, is the primary facility of the system. Sixteen missions will be scheduled each year.

This one-chamber habitat consists of a wet diving area, laboratory facilities, and viewports for external observations. Four aquanaut scientists can live and work on the seafloor for up to two weeks under hyperbaric conditions. Additional laboratory space and equipment ashore can be made available for program participants.

The Caribbean program emphasizes acquiring via *in-situ* study, scientific information of coastal and tropical marine environments, development of new and improved underwater research and engineering techniques, instrumentation and equipment. Missions are encouraged which address at least one of the following categories:

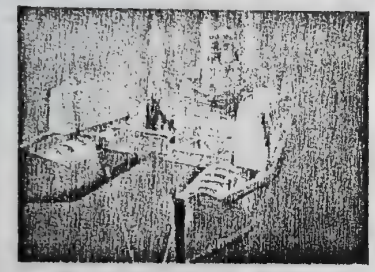
1) Marine resource assessment, conservation, development, and utilization.
2) Man-induced effects on marine ecosystems.
3) Impact on offshore energy development.
4) Dynamic oceanographic processes.
5) Underwater biomedical research.
6) Equipment test and evaluation.
7) Scientific diver aquanaut training.

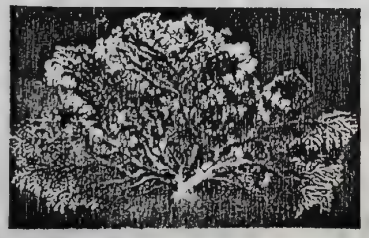
The Hawaii Undersea Research Laboratory

The Hawaii Undersea Research Laboratory (HURL) program operated by the University of Hawaii, is located on the island of Oahu at Makapuu Point. Offices and laboratories are available at various university complexes, including the Oceanic Institute and the J.K.K. Look Laboratory of Oceanic Engineering. The HURL Program emphasizes the use of man-in-the-sea research activities for the Pacific region centered in the Hawaiian archipelago.

Hawaii's manned undersea facilities consist of the submersible MAKALII, its launch-recovery-and-transport platform (LRT), and a surface support vessel. The MAKALII is a two-person (pilot and scientist) one-atmosphere submersible with an operating depth of 1200 feet offering scientists direct observing, sample collecting, and instrument implanting capabilities. The LRT—designed specifically for launching and retrieving the submersible in rough Hawaiian waters—is itself a towed wet submersible platform controlled by SCUBA divers. Under certain conditions it could also be used as a diver support platform or work station. Several support vessels owned and operated by the university and other facilities and resources needed for a sophisticated and flexible marine laboratory are available. The HURL science program stresses the evaluation and development of natural resources, energy sources, and the environmental processes relevant to improved management of marine ecosystems.

Makalii being launched from LRT





Pink Coral viewed from Makalii

Research locations could include not only the entire Hawaiian archipelago but also other areas of the Pacific.

The Southeastern Undersea Research Facility Program

The Southeastern Undersea Research Facility (SURF) Program operates under the aegis of the Southeastern Consortium for Undersea Research Efforts (SECURE) which is led by the University of North Carolina at Wilmington. SECURE consists of academic and research institutions and government agencies from Virginia, North Carolina, South Carolina, and Georgia.

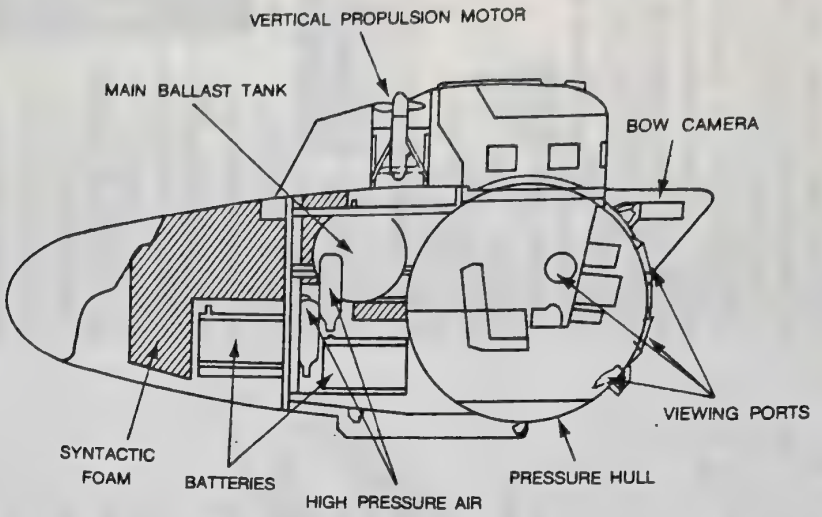
The objective of SECURE and the SURF Program is to provide a unique undersea research program and facility to accommodate a wide range of marine science needs. Initially, the research system will provide for surface supported SCUBA, surface tethered diving, and open bell diving research operations on the continental shelf. The surface support ship R/V SEAHAWK—an 80 ft. ship configured specifically for offshore mixed gas diving operations—is the principal undersea facility offered by SURF. In addition to the diving system she can accommodate four scientists, provide onboard laboratory facilities, and has a fully operational double lock decompression chamber. The open diving bell is a safety refuge during decompressions and in emergencies, can be used as a work platform, and provides a means of transport for research divers from the surface support ship, R/V SEAHAWK, to the seafloor at depths to 150 feet, or at points in the midwater column. The system will be based out of Wilmington, North Carolina.

Support ship RV Seahawk

Surface supported wet bell

SECURE's program will focus on research in marine fisheries, seafloor properties and processes, marine pollution, and ocean services. In addition to the system described above, cooperative missions may be conducted with institutions experienced in more sophisticated undersea platforms such as submersibles.

THE UNIVERSITY OF HAWAII -- HAWAII UNDERSEA RESEARCH PROGRAM
announces OPPORTUNITIES FOR RESEARCH with the SUBMERSIBLE MAKALI'I
in the Pacific Ocean



The submersible Makali'i is owned by the University of Hawaii and operated by the Hawaii Undersea Research Laboratory (HURL) under a grant from the National Oceanographic and Amtospheric Administration (NOAA). HURL is one of four national laboratories sponsored by NOAA's Office of Undersea Research (OUR).

REQUESTS FOR 1984

Submersible time requests are now being considered for Makali'i use in the Pacific. Letters of intent to use the submersible should be received before February 15, 1983 and completed 4 to 8 page time requests should be submitted before April 1, 1983.

Based on recommendations from the HURL science review panel, qualified research projects will be selected and ranked on the basis of scientific merit and evaluation of the Makali'i as a suitable vehicle for the project. The following four research areas have been suggested by NOAA as appropriate, however, all time requests of scientific or technical merit will be carfeully considered.

1. Fisheries, e.g., ecosystem assessment and dynamics, habitat degradation and enhancement, harvesting impact, animal behavior and gear development.
2. Pollution, e.g., manner and physical effects of waste disposal; behavioral biochemical and physiological responses of marine organisms to pollutants.
3. Sea floor properties and processes e.g., geological, geochemical, and geophysical aspects including gradients in the water column near the sea floor, sediment transport, stability, fluxes, and mineral resources.
4. Ocean technology and services, e.g., marine sanctuary monitoring, engineering, equipment testing and recovery, medical and diving physiology, archaeology.

Diving locations will be contingent upon the number and quality of approved proposals received as well as logistical considerations.

Requests for use of the Makali'i should be initiated by sending a completed time request form (overleaf) to: Science Program Coordinator, Hawaii Undersea Research Laboratory, Room 232 Marine Sciences Bldg., University of Hawaii, 1000 Pope Road, Honolulu, 96822 HI. Requests may be made by scientists and engineers at any university or research institution in the United States, and should be supported by a research proposal.

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To obtain further information regarding Makali'i, specialized equipment or services, contact:

Rick Wilson, Director of Operations
Hawaii Undersea Research Laboratory
Makai Research Pier, Makapuu Point
Waimanalo, HI 96795
Telephone: (808) 259-9991

Questions about science which can be accomplished with the Makali'i should be adddressed to:

E. H. Chave, Science Coordinator
University of Hawaii
Marine Sciences Building, Room 232
1000 Pope Road, Honolulu, HI 96822
Telephone: (808) 948-6335

DESCRIPTION OF THE MAKALI'I

The Makali'i is a battery powered, 1-atmosphere submersible. It is 4.77 meters (15 feet) long and has a pressurized capsule 1.54 meters (5 feet) in diameter. It carries a pilot, one observer and a payload of up to 95 kgs. Normal operating speeds range from 1 to 4 knots. Dive duration is 4 to 5 hours with life support for 72 hours. Its depth capacity is 380 m (1200 feet).

Equipment carried by the submersible includes:

1. hydraulic manipulator
2. sample storage baskets
3. color and low light black and white video cameras and monitors
4. flood lights and video camera lights
5. 35mm still camera and strobe
6. current and temperature meters
7. instrument package containing, temperature, conductivity, oxygen and pressure probes, real time and solar recorders
8. dictaphone tape recorder
9. water and grab samplers
10. suction device for obtaining small or soft bodied organisms
11. directional antenna and pingers

A precision navigation system is being obtained by NOAA and will be available by 1983.

Additional equipment must be supplied by the scientists, however, the nature and application of this equipment must be discussed with the operations team so that it can be adapted for use on the Makali'i. HURL may be able to fabricate additional requested items provided the cost is minimal and the request is made at least three months in advance of its use.

LAUNCH, RECOVERY AND TRANSPORT VEHICLE (LRT)

The LRT was designed specifically to transport and deploy the Makali'i in oceanic waters. It is a wet submersible platform controlled by scuba divers, and towed to a dive site by a surface support vessel. The LRT submerges with the Makali'i to a depth of about 17 m where the submersible is released by support divers. The LRT then resurfaces. On completion of a Makali'i dive, the LRT submerges again, the Makali'i lands on its deck, is secured and the LRT and Makali'i are brought back to the surface. This operating procedure ensures a safe subsurface launch and recovery of the Makali'i in up to 12 foot seas.

HAWAII COASTAL ZONE DATA BANK (HCZDB)

Through HCZDB, HURL offers a $220 data package for each dive. This package provides a complete set of materials including a voice tape transcription, instrument data printout, a copy of the videotapes, duplicates of up to 100 slides, and a data summary listing. HCZDB acts as the custodian of the original data which is the property of HURL. It organizes and archives the data so that any part of the material taken on a dive can be retrieved for the project leader, duplicated and sent to other experts for analysis, and is available to other scientists who need the pinpoint information for their researches. The project leader may request that permission to use these materials be subject to his or her approval for up to two years after a dive. It is suggested that funds be alloccated for the service in a supporting research grant.

Western Regional Undersea Laboratory

A Western Regional Undersea Laboratory (WRUL) Program is being developed by the University of Southern California at the Santa Catalina Marine Science Center, located off the coast of California. The center is a fully operational academic campus actively involved in undersea research with a year-round program of teaching and research in marine biology and its associated disciplines. Extensive laboratory, classroom, and living facilities are available.

The science center, located at Big Fisherman's Cove at the isthmus of the island, offers research opportunities in a major temperate water ecosystem. The site is located amid a lush bed of giant kelp adjacent to an extensive rocky reef and a biologically productive soft bottom of shelly sand. The waters are calm and clear, having normal visibility range of 40 to 100 feet. This area is considered by many to be one of the most productive and unique, although largely unstudied, of all major undersea biomes—a dynamic three-dimensional ecosystem supporting a number of biological communities.

The research facility—a double lock undersea saturation habitat with a diver "wet" porch—will accommodate six personnel. It will provide scientists with both living and laboratory quarters and the ability to enter into the water and conduct *in-situ* operations. Mission duration will be one to two weeks. The habitat sites will be at depths ranging from 60 to 120 feet in the well-sheltered cove having direct access to the open ocean. The habitat system is presently under development with 12 to 16 missions planned per year.

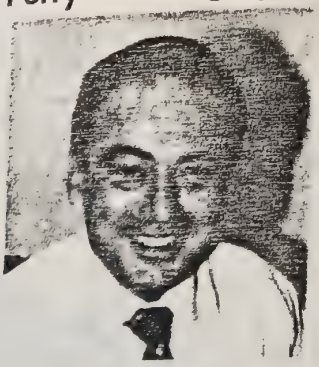
Possible areas of research include: Marine Fisheries, Marine Ecology, Oceanography, Marine Pollution, Seafloor Properties and Processes, Human Physiology, Marine Geology, and Energy Resources.

Study Available on Acoustic Properties of Marine Seeps

A study commissioned by seven oil companies on the acoustic properties of natural marine gas seeps is now for sale to other companies, especially those engaged in offshore exploration. The study, covering a period of almost a year was conducted by Nekton, Inc.

A manned submersible was used along with a surface vessel for two months of field operations in the Santa Barbara Channel area. The report offers methods of determining seep intensity, distribution and seismic and acoustic devices including side scan sonar and various types of echosounders.

Dryfka Named Special Projects Program Manager At Perry Oceanographics



John Dryfka

John Dryfka has been named program manager for special projects for Perry Oceanographics, Inc., Riviera Beach, Fla.

Mr. **Dryfka** manages special projects, proposals, and programs, and is presently managing the three-system Cal Dive project. During his 24 years in the U.S. Navy, he was responsible for at-sea operational direction of deepsea and saturation diving complexes, including manned and unmanned submersibles.

His initial years were devoted to submarine engineering, ship salvage and repair, and personnel training. During his last seven years of service, Mr. **Dryfka** was the officer in charge of diving schools, ships, units, detachments, and deep submergence rescue vehicles.

Pisces Sets Explosive Charges Offshore Italy

International Underwater Contractors *Pisces VI* submersible recently set what is claimed to be an underwater work record while demonstrating its deep-diving capabilities. In April, the two-man, 2,530 m rated vehicle used its manipulators to place a chemical explosive charge into a permanent guide base (PGB) funnel in 382 m of water offshore Italy. The submersible surfaced and the charges were remotely detonated from topside. The half-million dollar PGB was then lifted into the drillship through the moonpool doors for reuse. On the same job, *Pisces VI* threaded the drill pipe with the running tool used to hoist the PGB. The submersible set the world spudding-in record of 1,486 m off Newfoundland in 1979. Also, a BOP stab-in at 701 m is still considered a record.

Review & Forecast

1982/1983 In the Undersea Service Industry

By James A. Lawrie
Marketing & Business Department
Solus Ocean Systems, Inc.

We're all well-acquainted with the effects of recent worldwide petroleum oversupply, associated depression of crude prices, 8% reduction in crude consumption due to recession and energy conservation—major trauma in the petroleum industry. The response of many of the oil companies to falling profits was the slashing of exploration and production budgets for 1982. Land operations were affected most rapidly because of shorter duration contracts, but offshore activities increasingly felt the effect in the second half of the year. A typical barometer of the industry, offshore rig utilization, shows a current 15% stacking level for semisubmersibles and drillships—worse than the 13% previous low point experienced in 1978.

Despite the market chaos, the undersea service industry fared reasonably well. Industry revenues rose to an estimated $600 million, but in the latter part of the year competitive pressures resulted in margin compression and associated decline in profitability. In the exploration sector there was substantial stacking of older rigs and reduction in diving support, but 30 new deepwater semisubmersibles and drillships were added to the fleet. Although some of these are supported by manned diving, the majority are equipped with atmospheric work systems or unmanned tethered submersibles. Typical are three new semisubmersible rigs aboard which Solus has installed two observation manipulator bells and the first dual HYDRA™ an unmanned, tethered submersible (UTS) specifically configured for rig support.

On the construction side, the market was essentially level with West Africa, Southeast Asia and Australia showing notable increases. Hidden amid the current negativism is the fact that 1982 saw the installation of a record 379 fixed platforms around the world.

The inspection, maintenance and repair market continued to grow during 1982 and represented 47% of undersea industry revenues. The continuing growth of this market reflects increasing concern for maintenance of existing production, growth in regulatory inspection requirements, and the continued addition of new offshore facilities. Noteworthy trends during the year have been increased usage of UTS/diver combination inspections; more detailed inspection requirements, and extensive use of dynamically-positioned (DP) vessels in the North Sea as inspection and repair platforms.

During 1982 the application of unmanned tethered submersibles continued to show strong growth. The number of vehicles in service increased 32% over the previous year. Several of these were second generation UTS which incorporate knowledge and improvements gained from several years of operating experience to provide vehicles with greater power, reliability, and work capability.

I believe 1983 should witness a return to stability in the offshore marketplace. Although exploration and production budgets of most of the major oil companies will remain flat, the general 25% decline in rig day rates will permit an increased level of overall activity. Increased exploration off Canada, Alaska, China, and the U.S. West Coast will result in moderate expansion of this aspect of the undersea service industry. The use of unmanned tethered submersibles will continue to gain strength in rig support at the expense of manned diving. As the vehicles continue to improve in work capability, and demonstrate cost effectiveness, reliability, greater safety and operational depth, the rate of change to UTS will quickly accelerate. Typical for 1983 will be the use of a Solus HYDRA™ system for drilling support in the Baltimore Canyon below 610 MSW.

With the exception of the major Norwegian Gas Gathering Project, undersea services in support of construction will decline from the 1982 level. West Africa is the exception with increased construction forecast. The market will be down significantly in Central America, the U.S. Gulf Coast, and the Middle East.

Underwater services associated with inspection, maintenance and repair are expected to increase 11% in 1983. Significant trends will be an increase in fixed price contracting, use of more refined inspection techniques, expansion of the use of DP vessels outside the North Sea, initial development of UTS specially configured for platform cleaning, and increased use of dual vehicle systems (introduced by Solus in 1982) to provide increased operational reliability and self-rescue capabilities.

ROV Outfitted With Osprey LLTV, With Space Savings

Osprey Electronics Ltd., Aberdeen, Scotland, has overcome a space problem with an ultra low light level television camera they specially designed and manufactured for installation aboard the I.S.E. Dart remotely operated underwater vehicle.

The space inside the Dart's pressure dome restricted the use of a conventional underwater camera. Osprey overcame this by producing a camera in two parts. The first incorporates a Silicon Intensified Target (S.I.T.) television tube and lens assembly on pan and tilt in the dome with associated electronics; the second has the drive electronics and timing function printed circuit cards both of which are plug-in for ease of maintenance and are housed at the rear of the vehicle.

The camera has improved the capability of the Dart, particularly where the video quality has allowed the pilot a much greater depth of field and also a wider angle of view, according to users.

Four vehicles have been fitted out to date for Solus Ocean Systems, with two being used in the North Sea and two in the Far East. An additional underwater camera has been fitted to the vehicle garages to improve tether management.

Manned to unmanned conversion in less than an hour

The first submersible which can be converted from a manned into an unmanned vehicle, Mantis Duplus, has been delivered by OSEL to KD Marine Atlantic, for work offshore Canada for Husky Oil. Two systems have been purchased and a further two will be supplied as back-up.

The Duplus system has three working modes; it can be piloted, operated entirely on remote control from the surface without a pilot inside, or, in very unusual circumstances, a manned Duplus can be remotely controlled.

The demand for such a vehicle came originally from platform operators already using the Mantis, who wanted a vehicle operable in an emergency situation when sea conditions made it dangerous to send a man down. Providing a Duplus is very cost competitive compared to retaining both a manned submersible and unmanned submersible. Equally important perhaps is the saving in precious topside space. Conversion time from one mode to another is said to be less than an hour.

Apart from the telemetric umbilical-fed remote controls, the major modification converting a Mantis to a Duplus consists of inserting lead weights to maintain the trim, and adding on a set of eight extremely powerful ac 660v 3.0 thrusters. Fitted on an OSEL Wasp on an experimental basis, the pilot was able to make the Wasp jump straight out of the water, like a dolphin.

The power of these thrusters is reckoned to deliver about 3.5 knots. This is necessary in an unmanned mode because tests have shown that if the precision of piloted control is removed, extra power is required to perform the same tasks.

Basic configuration of the Duplus is the same as the Mantis. The pressure hull is constructed from a carbon fibre reinforced plastic cylinder which is assembled to forward and after body-ring castings of aluminium. The forward acrylic dome and the after access dome are fitted to these rings. The whole assembly is internally braced by tie bars and bridged externally by a structural beam to the centre which is fitted with an umbilical lifting arrangement. Maximum operating depth is 700m.

Equipment carried external to the pressure hull is grouped into assemblies which can be jettisoned to allow the pressure hull complete with life support system to come to the surface by means of a fixed buoyancy pack. If the umbilical has to be jettisoned, the vehicle can be propelled on full thrust for at least one hour by means of two dc thrusters fitted to the sidepods and powered by onboard emergency batteries.

Rules of navigation subject for new book

The revised edition of the Coast Guard publication "Navigation Rules, International-Inland" is now available through the Government Printing Office.

Federal law requires that in 1983, a copy of the new "Navigation Rules, International-Inland" must be kept for reference on board all boats of 12 meters (39.4 feet) or more in length operating on inland waters.

All boat operators, regardless of the size of their vessel, are expected to know and comply with the inland navigation rules, which became effective Dec. 24, 1981, on all inland waters except for the Great Lakes. The rules are effective March 1 on the Great Lakes.

The international rules which govern the operation of vessels outside U.S. waters have been revised by 55 amendments effective June 1 this year. The Coast Guard book contains all of these changes.

The Coast Guard stresses that familiarity with the navigation rules is one of the surest ways to make vessel operations safer and more enjoyable for all concerned.

Price of the Coast Guard book is $6.50.

It may be ordered by name, "Navigation Rules, International-Inland," and stock number, 050-012-00192-8, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Purchasers should send a check or money order payable to "Superintendent of Documents."

VISA or MasterCards may be used if the purchaser provides his/her name exactly as it appears on the card, identifies the type of card, its number and expiration date.

Also, telephone orders may be placed by calling (202) 783-3238.

The navigation rules book must be aboard vessels longer than 39 feet, Coast Guard officials explain.

Subsea Habitat Designed For Installation Off California

Perry Oceanographics, Riviera Beach, Fla., has completed the detail design of a subsea habitat being developed for NOAA and the University of Southern California. The habitat is called the Western Regional Undersea Laboratory.

The habitat, which later could be used in the offshore market, will be installed off Catalina Island near the USC Science Center. The 12 m long habitat will be able to accommodate six divers for durations up to 30 days in water depths up to 76 m. The state-of-the-art habitat will be buoyant and will use a hydraulic winching system to pull itself down onto a highly negative base plant which will be secured to the bottom with pilings and 5,000 pound cubes.

Anode Installation Vehicle Tested in Gulf of Mexico

JERED, Inc., a Houston, Tex., firm which operates exclusively remotely-operated vehicles in the Gulf of Mexico, has successfully tested an anode installation vehicle. The unit utilizes a concept conceived by Shell Oil Company engineers and was proved to be able to deploy and attach 180 kg anodes to structures in water depths exceeding 335 m.

The technique of attaching sacrificial anodes with remotely-operated vehicles offers a cost savings advantage over previously used diver installation methods. (For more on the technique see p. 35).

The vehicle was built by Perry Oceanographics, Riviera Beach, Fla.

Sea floor images represent global snapshot from data collected by NASA's Seasat satellite

Major geologic features on the ocean floor have been captured in images recently produced from data collected by the Seasat oceanographic satellite, flown by NASA in 1978.

Seasat was designed and constructed by LMSC under contract to NASA. It was intended to prove the feasibility of using a network of satellites to continuously monitor the oceans of the world, sending back information on surface winds and temperatures, currents, wave heights, ice conditions, ocean topography, and coastal storm activity.

It circled the earth 14 times daily and covered 95 percent of global oceans every 36 hours, using primarily microwave sensors to provide its worldwide data.

Every image represents a global snapshot of sea floor characteristics never before available and at least one previously unknown feature is revealed.

The images were made by measuring the topography of the ocean surface with the satellite's altimeter. The global image is comprised of more than 50 million physical measurements including 10 corrections for atmospheric and other interferences. They were produced from the same data, but each was processed differently to emphasize a unique set of features.

The images supply new, detailed bathymetric (water depth) and geologic information for wide areas of the world's seas. Seasat collected 10 days of oceanographic data over a 100 day period. The radar altimeter measured the distance from the spacecraft to the ocean surface. By calculating the satellite's position, and correcting for passage of the radar beams through the atmosphere, the height of the ocean surface, relative to a reference ellipsoid, was determined.

The resulting maps, which show the ocean surface at one-half degree resolution, were created through computer processing of the Seasat altimeter data. They were designed to emphasize features on the ocean floor ranging in size from 30 to 300 miles.

Mapping the sea floor by measuring the sea surface topography is possible because of the relationship between gravity, the sea floor and the ocean. Gravity over the earth is not constant and varies depending on the local thickness, density, age and geology of the crust.

The ocean conforms to variations in this uneven gravity field because it is a fluid. Sea surface topography dominantly conforms to the sea floor topography. A mountainous formation on the sea floor, for example, causes a peak on the ocean surface detectable by a satellite altimeter.

Mini Sub, Underwater Light Reveal Russian Sub Details

When a Russian submarine, snooping around restricted waters near a Swedish Naval base, ran aground, measures were taken to gain information about the boat.

According to Ralph Asplund, an official with the company SUTEC (Scandinavian Underwater Technology), the company delivered its first tethered and remotely operated mini submarine, called the *Sea Owl*, to the Swedish Navy.

Sea Owl was placed aboard a frigate and along with its camera equipped with underwater lights called Snooperettes, manufactured by Birns Oceanographics, Inc. With the big sub helpless, the *Sea Owl*, swam around it. Detailed pictures were taken which included the torpedo ports, sonar and electronic gear and other details.

Sub completes tasks on subsea tree

A manned work submersible equipped with adequate manipulators and tools can service subsea trees rapidly and with no diver intervention.

That was the consensus following the test program "Diverless Underwater Intervention" sponsored by a group of oil companies and held under the sponsorship of Det norske Veritas on a christmas tree installed near the Nutec facilities in Bergen.

During the project, a joint team from Germany's Bruker and the new UK offshore service company Scotsub performed work tasks using the diver lock-out submersible *Mermaid IVA*.

The program, designed to analyze the accessibility of different sub-systems when using a relatively large manned submersible, included the following tasks:

- Inspection of tree components by a surveyor within the sub
- Video documentation
- Operating a release buoy
- Actuating ball valves for system controls
- Connecting/disconnecting hydraulic hot lines
- Removing and replacing corrosion cap on master valves
- Operating master valves
- Cleaning completion cap mandrel with rotary brush
- Cleaning flowline connectors with water jet
- Exchanging AX gasket on christmas tree
- Cleaning concrete structure for visual inspection
- Connecting a lifting rope to a shackle
- Cutting guide wires with hydraulic cutter
- Cleaning hydraulic connectors for completion cap via specially designed brush
- Assembly/disassembly of electrical cable connector
- Disassembly of screws/bolts with impact wrench.

In addition to proving the submersible's capability, the test program also provided some data useful for designing components of subsea completions systems that will provide better maintainability and serviceability.

BELLFINDER MODIFIED FOR NAVIGATION ROLE

Ordinarily the Model 5450 Diver-Held Interrogator of the Helle-Bellfinder System resembles a hand-held cannon complete with pistol grip. And ordinarily the interrogator is used to locate lost diving bells by transmitting to and receiving signals from a Model 5400 Acoustic Transponder attached to a bell.

Now a Helle-modified version of that system--along with 10 pingers--will be used by the crew of a two-man sub for navigation and relocation purposes in the Santa Barbara Channel. The accompanying photo shows the standard 25.3 inch (59.7-centimeter) transponder and the highly modified interrogator unit in three sections for its new role inside the cramped submersible. Electronic components and alkaline batteries are contained in the larger box, directional hydrophone in the cylindrical object and digital readout in the smaller box. The hydrophone also is used with a Model 6120 Pinger Receiver to home in on the 10 pingers. The transponder is to be used as a point of reference.

SPECIALS DEPARTMENT FULFILLS SPECIAL REQUIREMENTS

More than just the standard line of quality Helle products are available, as many customers have learned. We also provide custom-built products and systems to serve special requirements. Operators of a mini-sub wanted pingers that would activate when removed from external, vertical storage racks and placed on their side on the ocean floor. Our Specials Department responded by supplementing the standard submersion switch with a mercury switch on several Model 1327, 1337 and 1427 Pingers. The battery life of each pinger also was more than doubled.

Another example: Our new Model 6505 Hand-Held Directional Antenna comes with a three-foot shaft that telescopes to six feet. Upon request, we extended the standard shaft so that it could be expanded to about 10 feet and thus through thick Alaskan ice.

PINGER BEING MADE FOR DEEP SUBMERSIBLE

Ametek-Straza has asked Helle to design and build a special pinger that will operate on one of its remotely piloted submersibles (RPS) at depths as great at 6,000 feet. At no extra charge to the customer, our engineers and technicians are manufacturing a Model 2565 Pinger to operate down to 10,000 feet. It will receive its power from the RPS, instead of from pinger batteries, and will transmit one pulse every 13 seconds with 20 watts of power at 27 kHz. If you have a special pinger--or other--requirement, contact a Helle representative.

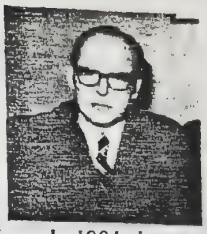
The special Model 2565 is to be used attached to the SCARAB vehicle which was developed to locate, unbury, attach lift lines and rebury transoceanic telephone cables. The open-framed submersible also is adaptable to other offshore work. SCARAB is the acronym for Submersible Craft Assisting Repair and Burial.

Stadive's submersible delivered

The four-man diver lockout submersible PC1805 destined for Shell's msv *Stadive* has been delivered by Perry Oceanographics.

The vehicle is over 8m long, just under 3m high and weighs 16t. Normal bottom time is claimed to be eight hours but this is reduced to four when on-board survey equipment is in use. The lookout compartment is designed for internal pressurisation to 200m, and the vehicle comes equipped with two six-function manipulator arms.

What Makes A Miner Mine?



James L. Malone has been a law professor, specialist in maritime law and the President's Special Representative to the Law of the Sea Conference. On June 1, 1981, he was sworn in as secretary of State for Oceans and International Environmental and Scientific Affairs. Last spring he became Ambassador-at-Large.

Claims are still being made that unless the United States is a party to the law of the Sea Treaty no mining of the deep seabed by U.S. miners would ever take place. As technical experts, I believe the readers of this publication are in an excellent position to judge if mining would be more likely to take place under the current treaty, or through an alternative regime.

I would like to set out the difficulties the Administration has with the treaty, then briefly describe the alternative course the Administration plans to follow. I leave the conclusion of which regime best supports the future of deep seabed mining to you, the reader.

In President Reagan's July 9 statement he announced his decision not to sign the treaty. At that time, he also outlined major problems the United States has with the deep seabed portion of the treaty.

First, the treaty terms actually deter the future development of deep seabed mineral resources and do not assure future U.S. access to the seabed. Hindrances to mining include exorbitant fees and costly regulations. A mining company, for example, would be required to pay $1 million a year while exploring a site. This fee would ensure only that the firm has the right to request the international authority to review its application. Many other fees would be required once a company has been granted the right to mine.

Among the most onerous regulations is one requiring a mining company to explore two mine sites for every site it wishes to mine. Upon making application to mine a site, a company presents exploration results for both sites to the bureaucracy created in the treaty—the International Seabed Authority.

The Authority will retain one site of its choosing, giving that site to the U.N. international mining company created by the treaty known as the Enterprise, a part of the ISA. The Authority may allow the private company to mine the other site it has explored but there is no certainty that a company will receive authorization to mine a site even if all of the specified requirements have been met.

A second problem the United States has with the treaty is that the decision-making process failed to give the U.S. and many other nations a role which fairly reflects and protects their interests. The U.S. would not have the ability to prevent discriminatory treatment against a U.S. company. Despite that fact, the U.S. would have been required to pay one quarter of the costs involved in implementing the treaty and establishing those organizations mandated by the Authority would have the power to require companies to transfer newly-developed technology to the Enterprise. Compensation for "selling" this technology would be, at best, highly uncertain. In addition, most of the technology and systems would be proprietary; therefore, the miners would not want to transfer them under any circumstances.

Though not mentioned in the President's statement, another difficulty is the imposition of production limitations. These limitations were developed to protect the countries whose economies are based on current land-based production of minerals.

Arguments have been made that the limitations really have no practical application. Whether or not this is true, the production limitations will distort the pattern of investment by preventing it from responding to the marketplace.

These are some of the major difficulties which confront a company wishing to mine the seabed under the current Law of the Sea regime.

The United States recognizes that today's world demand and markets do not justify adequately commerical development of deep seabed mineral resources and that it is not clear when such development will be justified. When such factors do become favorable, however, the deep seabed may represent a critically important source of strategic and other minerals.

The aim of the United States has always been to establish with other nations an order that would regulate exploration and development under reasonable terms and conditions. The Law of the Sea Treaty simply does not provide a viable regime for seabed mining by any nation.

An alternative international arrangement is needed. Consequently we are now engaged in a dialogue with those nations with serious seabed mining interests to develop an alternative regime which will encourage the efficient development of deep seabed resources.

Thus the choice lies between trying to mine under a Law of the Sea regime which is known to be seriously flawed or to develop an alternative which has positive incentives for seabed mining and protects U.S. access and interests. The President has wisely chosen the latter course.

At bottom, such a question becomes an article of faith. Should our nation have accepted and signed a treaty which bound us with the full force of international law to terms and conditions which may well prove injurious to our nation's future security and well-being?

Or should the government's responsibility to its citizens, present and yet unborn, and to the business and industrial interest which convey to Americans much of their exceptional standard of living, require the fullest protection of America's potential use of the earth's last great frontier –the deep oceans? Let the reader decide.□

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Md. 20852

March 3, 1983

Dear Colleague:

NOAA's Office of Undersea Research, formerly MUS&T, is requesting your assistance in helping us to prepare documentation to maintain and enhance our support to the marine community.

Enclosed you will find a survey sheet. Please take time to fill in this information; be very specific. It will be used to aid us to obtain future funding.

To expedite this, we have enclosed a return mail envelope. We will appreciate a return at your earliest convenience.

Thank you.

Sincerely,

Elliott A. Finkle

Elliott A. Finkle
Director
NOAA Office of Undersea
Research

Enclosure

-30-

Results from NOAA Undersea Research Program's

Supported Undersea Research Activities

Name _____ Address _____

Phone Number ( ) _____ _____

Research

A. Category (behavior, habitat, life history, physical & chemical oceanography, etc.)

_____

B. Site(s) _____

_____

C. Dates _____

D. Description of your research project _____

_____

_____

_____

_____

Method

A. Type of undersea facility used (manned habitat, submersible, closed or open bell, scuba, surface supplied air or mixed gas, decompression chamber, etc.)

_____

B. Reason for using manned undersea techniques rather than other means of conducting your research

_____

_____

_____

Value

A. Value of your research to the national interests including one or more of the following: (1. Direct economic value in dollars if you can, 2. Marine resource management, 3. Marine resource enhancement including aquaculture, 4. Habitat protection, 5. Pollution abatement and control, 6. Marine resource utilization, 7. Other)

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_____

Please return to: NOAA Office of Undersea Research
R/SE-2
6010 Executive Blvd.
Rockville, MD 20852

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

JULY, 1983

Vol. XVI, No. 2, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to deep submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

Robert K. R. Worthington
Editor, DSPA
754 Buck Ave.
Vacaville, CA 95688
(707) 447-7235

or

Thomas G. Vetter
Secretary, DSPA
7309A Alicante Rd.
Carlsbad, CA 92008
(619) 438-3903

Correspondence regarding DSPA policy or membership should be addressed to:

Willis Forman
President & Membership Chairman, DSPA
1527 Linwood Street, Apt. 5
San Diego, CA 92103
(619) 295-0620

EDITORIAL NOTES AND COMMENTS

Lament of an Editor with a dearth of contributors (of copy, I mean, not funds!)---Our only regular contributions come from Alan Whitfield and Larry Megow. My sincere thanks to them and ,also, to all occasional letter writers. Once upon a time, there were frequent contributions from ALVIN and Kevin Parker; but their inkwells have run dry. It appears to me that there must be enough excitement and spare time in every DSPA Member's life to engender at least one brief report per year. Of course, I realize you all lead pretty dull lives; but lie a little!

SUBNOTES, a monthly report of events and people in the underwater field,is edited and published by Deam Given at PO Box 368, Spring Valley, CA 92077. Subscription : $100.oo/yr.; $120.oo/yr. overseas. Your company may be interested in subscribing.

Will Forman's letter to all Members, dated 19 June 1983 gets his Presidency off to flying start. Please, let's all help him keep the ball rolling. Be an ACTIVE Member! Will's letter to me reporting on the June monthly luncheon is included below rather than trying to condense it here. Will informs me that his survey of opinion regarding acceptance of Japanese deep submersible pilots as Members of DSPA resulted in widespread approval.

New Members recently welcomed on board include the following:
Patrick K. Baccei (U.S.N.)-O-in-C DSRV-1 (MYSTIC)
Peter J. Dullea U.S.N.)-Ass't O-in-C DSRV-2 (AVALON)
Shaun M. Nerolich-ALVIN
Robert L. Lloyd (I.U.C.)-MERMAID 2; MANTIS 9,10,11
Jay A. Johnson (Associate Member)- NEKTON

Revised DSPA Address List will be forthcoming soon: Atleast, that is what my usually unreliable sources advise me. With my recent poor track record in getting out Newsletters on schedule in consideration, I'm not the right one to complain. But, like John Wayne, I never let that stop me before so why should I let it stop me now!?

NEWSLETTER reproduction and mailing responsibility seems to have fallen on Don Saner's broad shoulders, at least for the present. I will mail the originals to him on 18 July. How is that for putting on the old squeeze? "Dirty pool!", screams Don, reaching for his blanking out tape.

OCEANS '83- I hope to see many of you at the Conference Tuesday, August 30 sessions on "Manned Undersea Vehicles and Habitats" and "Remotely Operated Vehicles". The San Francisco Hilton, starting at 0820, of course. Sorry, but there is no DSPA meeting planned. Let's just get together anyway. Wear your DSPA insignia.

NEWS FROM MEMBERS

Will Forman--(6/17/83)
"A quick note whilw yesterday's DSPA luncheon is still fresh in mind. The excellent turnout of 20 attendees included 12 Members of DSPA, 6 U.S. Navy. I introduced the new Board of Directors, made note of your letter requesting inputs from projects and DSPA Staff, and circulated SUBNOTES for scanning. Lary Townson of W.T.W. Promotions was introduced by Tom Vetter and announced a proposed submersible race, at the surface, between piers in the Los Angeles area. Our speaker was Norm Estabrook of NOSC. He presented slides and video cassette on tetherless ROV's, including a testbed vehicle at NOSC and EPAULARD of France used for locating an SBD airplane on the bottom. An overview of various tethered ROV's was included as introduction. Our new speaker coordinator Nihil Smith and Secretary Tom Vetter will work out a schedule of forthcoming speakers, including ComSubDevGruOne for next month. Saner, Vetter, et al, finished an updated mailing list. In lieu of a President,s Message in the next Newsletter, I intend to send out a letter to Members. I am quite pleased with the amount of member assistance that has been volunteered and am using every ounce of it."

Alan Whitfield--H.M.B. Subwork (04/28/83)
"Please find enclosed the latest I.U.P.A. Newsletter. I will shortly be moving from MANTIS offshore Norway to another project in the North Sea. I'll tell you all about it next time. Regards to all."

Larry Megow--Hahn & Clay Heavy Industries (4/12, 5/10, 5/13, 7/12/83)
"Here's Kawasaki's news release on another Japanese submarine, OKISHIO. Not in our deep submersible class, but some of your readers may be interested in it."
"Attached is a brief summary of the 1983 OTC. This year it was a pleasure to walk the miles of fabulous exhibits withour having to fight crowds. The show was good for spectators, but not so good for the OTC organizers."
"Some readers may be interested in the attached clipping of a two-man submersible. The inventor, Roland Maxwell can be reached at 538 Fergerson Street, Humble, TX 77338."
"In the July 1983 One Half Fathom, we learned that 'we' are finally going ahead with converting 'our' SEACLIFF into a 20,000' boat. I say 'our' because Hahn & Clay manufactured the original HY-100 hull for SEACLIFF. You should be interested to know that the Japanese are also on a 20,000' (6,000 meter) boat. Infact, Kawasaki has built an "ultra-high pressure seawater pump for building a deep submergence research vehicle"---sea attached clipping. We had better hurry before the Japanese beat us to the punch."

Ultra-high pressure seawater pump completed for building deep submergence research vehicle

With a subsidy from the Japan Foundation for Shipbuilding Advancement, KHI recently completed a new ultra-high pressure seawater pump which is indispensable for building a 6,000-m deep submergence research vehicle.

A deep submersible research vehicle dives by admitting seawater into its main ballast tank, and once having submerged deep under the sea, the vehicle adjusts its weight by admitting seawater to or forcing it from a variable ballast tank. This seawater control is performed through a seawater pump. At a depth of 6,000 meters under the sea, however, the water pressure reaches 630 kgf/cm^2 G so that the required pump must have a discharge pressure of more than that figure.

In the seawater pump completed by KHI, a hydraulic motor-driven disk (rotary swash plate) which is obliquely fitted in a casing rotates at high speed to drive surrounding five plungers, thus pumping high pressure seawater.

This is called the axial plunger type pump. The first unit of this kind will be installed on a deep submersible research vehicle currently being built by KHI for the Japan Defense Agency. A similar pump will also be used in a 6,000-m such vehicle in the future.

The pump has a rated discharging pressure of 630 kgf/cm^2 G (maximum: 755 kgf/cm^2 G), with a discharging flow of 6 to 9 liters per minute. The disk rotates at a speed of 2,000 to 3,000 rpm. The pump weights only 40kg.

The new pumps also features the use of ceramic materials for the plungers and cylinders so as to prevent abrasion caused by silt contaminated seawater.

The ultra-high pressure seawater pump is light and compact, and has low driving torque, high efficiency, high resistance to salt-water and excellent durability.

This new pump is most suitable as a power source for tools and machines that utilize seawater pressure instead of the oil pressure system conventionally used for underwater operations. Since the pump utilizes only the surrounding seawater, pollution of the sea resulting from oil leakage is avoided. ●

Self-made submariner

Thursday, May 12, 1983 Houston Chronicle

Handmade minisub resolves Humble man's yearning for ocean exploration

BY CINDY HORSWELL
Chronicle Staff

It looks like a flying saucer with two acrylic domes on top.

But the bathtub-size contraption takes to the water instead of the air. It is a two-man yellow submarine which was built from scratch by an Humble auto mechanic.

"I've always been curious about what's under the water. It's another world down there," said Roland Maxwell, 56, who lives alone in a motor home at 538 Ferguson.

His interest in submarines was first piqued around 1957 when he salvaged scrap off some reefs on the Florida coast. He would don aqua lungs, dive into relatively shallow waters and drag scrap onto one of his three boats.

On days when the sun beat down on the sparkling azure water and business was slow, he often daydreamed about having his own submarine to prowl the ocean floor.

Yet at the year's end, the price of scrap wasn't worth enough to haul it out of the ocean. So Maxwell went back to being an auto mechanic, his main line of work since quitting school in the fifth grade.

Still, he never forgot about submarines. He tried to research them at Washington, D.C., libraries: "I could get general information on subs, but nothing technical. It just wasn't available."

Over the next 15 years, he worked as a mechanic. Yet all the while he read anything about submarines that he could find from magazine articles to even manufacturers' brochures.

Finally, eight years ago, after returning home to Humble, he announced that he was going to build his own. He thought it would be a novelty and that he could sell lake rides in it.

His brother, Joe, 58, an air conditioning mechanic of Humble said, "I told Roland that he was crazy. I didn't think he would ever be able to do it."

But Roland Maxwell wasn't worried. He was like a master chef without a recipe, who had all the plans in his head.

He took his shopping list to a steel manufacturing plant where he bought stock items to make the body of the vessel; he then bought a 12-volt battery and two electric trolling motors that fishermen use on rowboats; as well as odds and ends including a couple of depth gauges, two plastic kitchen chairs and two large acrylic bowls. The cost was $1,700 — an eighth of the going rate for even a used minisub.

Then he spent about a year tinkering, welding and testing it out. To the surprise of all the skeptics, it worked.

Weighing about 2,240 pounds, the 4-foot diameter disk travels about 4 mph. It has been submerged to a depth of 20 feet but Maxwell thinks it could withstand the water pressure as deep as 66 feet.

Anyone going for a ride sits in a plastic chair and looks through an acrylic dome that encircles his head. Two can stay under water about 20 minutes, breathing the air naturally held inside the capsule. A longer stay would require an air pack.

As any submarine, the minisub has tanks or ballasts that take in water to make it sink and then has an air compressor that later blows out the water so that it will rise to the surface.

Maxwell sees only two drawbacks to his vessel: its heavy weight (he uses a truck to hoist it into the water) and that it floats only 8 inches above the surface (making it impractical for ocean travel because waves could slosh inside when the domed hatches are open).

But in sheltered waters such as lakes or rivers, he said his submarine can provide the ultimate joy ride. In fact, he sold rides in it at $5 a person at an area lake for a couple of months, but says he tired of it and could not afford liability insurance.

"We have settled the submarine on the bottom of a lake near us called Kickapoo and just watched the trout and bass swim up to the domes and check us out," said his sister-in-law, Ann Maxwell, 42. "It's real quiet. You can hear your heart beat."

She said she loves going down now, although the first time she panicked and felt a little claustrophobia until she got used to it.

Roland Maxwell said he once discovered a stolen pickup truck in the same lake that had been submerged in 14 feet of water.

Thinking it might be marketable, he has offered to sell plans for his sub for $25 in Mechanics Illustrated magazine and another publication. About 100 people from as far away as West Germany and Venezuela have bought them, his sister-in-law said.

Also, Maxwell has displayed his sub in the Houston boat show and this month showed it at Humble's Good Oil Days festival.

"Unless we put it in a tank so people can see it operate, most people won't believe it will work," said his brother, Joe.

It's saucer appearance is quite different from the traditional cigar-shape of most subs but that gives it added balance, he said.

Looking at his creation, which is now has a few rusted spots and peeling paint, Maxwell said, "It's a great toy. Something your neighbor ain't got!"

Tear drop type submarine "Okishio" delivered to JDA

A delivering ceremony of the 2,200-ton submarine "Okishio" took place at KHI's Kobe Works on March 1 with the attendance of Mr. Minoru Yoshino, Administrative Vice Minister of the Japan Defence Agency, and Mr. Masaru Maeda, chief of staff of the Maritime Self-Defense Force of the same agency, and other related dignitaries.

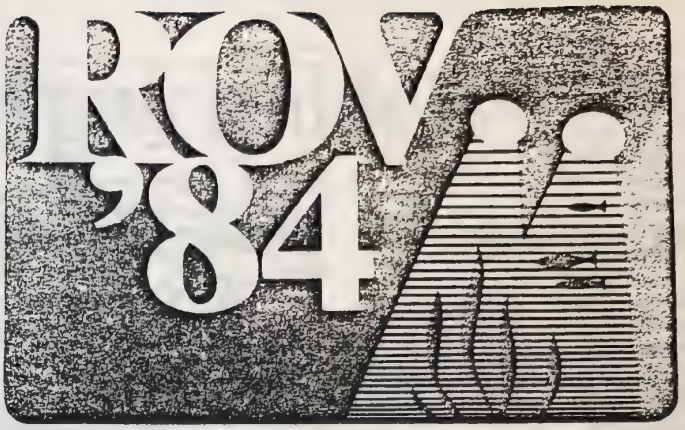
The keel of the "Okishio" was laid on April 17, 1980, and completion took place on March 1, 1982.

The vessel is the 21st submarine constructed in Japan after the World War II, and the fourth "Yushio" type submarine.

The "Okishio" has a tear drop type hull and outstanding capabilities for underwater motion and propulsion. The hull is made of high tensile steel and the vessel is equipped with various safety devices.

Principal particulars of the "Okishio":

Displacement	: abt. 2,200 tons
Length	: 76.0 m
Beam (maximum)	: 9.9 m
Draught	: 10.2 m
Main engine	:
Two Kawasaki-M.A.N. diesel engines	
Number of shaft	: One
Speed	: abt. 20 knots dived
Main armor	: 6 torpedo tubes
Special equipment	: Snorkel •



REMOTELY OPERATED VEHICLE CONFERENCE & EXPOSITION

MAY 14-17, 1984
TOWN & COUNTRY CONVENTION CENTER
SAN DIEGO, CALIFORNIA

Because of the huge success of the ROV '83 conference and symposium devoted to underwater remotely operated vehicle technology, we will sponsor ROV '84, May 14-17, at San Diego's beautiful and spacious Town & Country Convention Center. There will be more exhibits, more participants, more business and more technical exchange. Make your plans to be there!

Marine Technology Society, San Diego Section

For further information about exhibits, presentation of technical papers and registration, please contact ROV '84, P.O. Box 82253, San Diego, CA 92138

OTC attendance off 45% this year

By SAM FLETCHER
Post Energy Writer

Attendance dropped to 59,984 at this year's Offshore Technology Conference, the lowest figure registered for the world's largest oilfield trade show since 1975.

This year's attendance was well below last year's record of 108,161, and it even missed by a large margin pre-show estimates of 75,000.

Douglas L. Ducate, OTC general manager, said "it is remarkable that an event can be off 25 percent in exhibit space, down about 45 percent in attendance, and there still be such a warm feeling in the people that are here."

Ducate said it is too soon to evaluate fully this year's OTC. But he said he is satisfied with both the numbers and the nature of the 1983 show.

"It has been more manageable, with fewer problems and complaints," he said. "The three big problems traditionally have been food service, crowded aisles and parking." This year, he said, he's received no complaints in those areas.

Ducate said exhibitors also reported a more serious visitor to this year's show. "Where before two out of eight of the people exhibitors talked to were good prospects, this year it was two out of three," he said.

And there will be several changes when exhibits return in 1985. When the southeast quadrant of the Astrodomain parking lot was recently repaved in concrete, heavy duty conduit and utility channels also were put in place.

So in 1985, the outdoor exhibit will be moved to that location near Loop 610 and Fannin.

Moreover, Ducate said, another 110,000 square feet of floor space and a 7,000-square-foot lobby is being added to the Astroarena.

New Phoenix minisub a record breaker

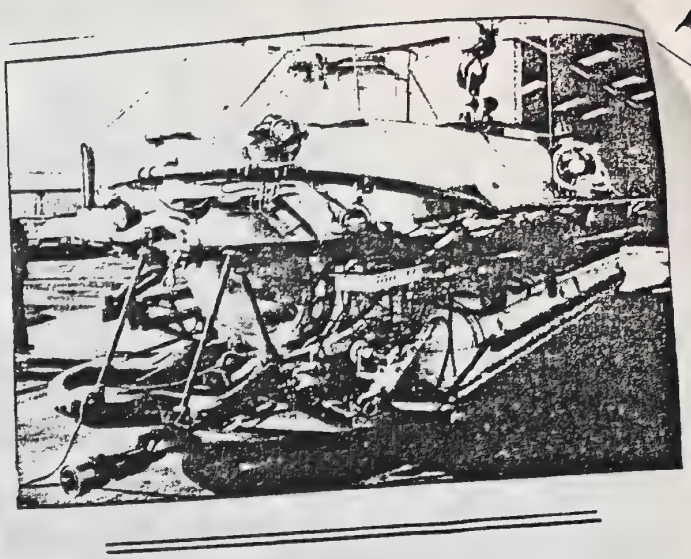
The problem of cold affecting saturation divers at great depths has been tackled by the Italian underwater engineering firm Sub Sea Oil Services which has incorporated a closed cycle diesel engine in its latest diver lockout minisub.

The Phoenix 1350, currently undergoing final sea trials at the firm's new base at Gaeta can work at a maximum depth of 350 metres for up to 20 hours — which is a breakthrough in comparison with present limits. The longer operating period will also improve the chance of rescuing personnnel trapped in an emergency when a submarine is immobilised on the seabed.

This minisub with powerful manipulators is essentially a multi-purpose vehicle for transportation of divers to their work locations with an underwater range of 250 nautical miles and maximum speed of 9 knots below the surface and 6 knots on the surface.

The pressurised or hyperbaric lockout chamber can accommodate four divers, who can work accurately helped by the very powerful thrusters on the outside of the minisub.

Building on wide experience of subsea vehicles



Slingsby Engineering's LR-5 designed to meet specific survey and diver lock-out requirements.

WHEN Slingsby Engineering launched in 1975 its first major underwater vehicle LR-2, a three-man submersible with glass-reinforced polyester (GRP) pressure hulls, it could not have really known how long it would perform in the North Sea.

Seven years later, after countless hours of subsea work primarily for Shell on the Brent field, it is still performing. The first of its kind worldwide, LR-2 has been followed by three other larger manned submersibles which have been designed to meet specific survey and diver lock-out requirements.

The first rov designed by Slingsby was an inspection vehicle for British Petroleum known as MMIM. This most complex concept involved an active garage and vehicle, each having its own data processing and control systems. The vehicle with a 91m range from the garage carries two feedback manipulators, high-pressure water cleaning systems, a range of television cameras, NDT sensors and a stereoscopic still camera.

Seadog, a cable trenching system designed for British Telecome International, was the next step along the high technology path. This rov, either free-swimming or bottom crawling, uses a water-jetting trenching system that can cut trenches up to 1m below the seabed. With a two pressure system (50 and 250 psi) it can fluidise sand and cut clay at a test trial speed of 0.25 knots.

SEL, a Yorkshire-based company with wide-ranging activities, has now been divided into two separate units. Slingsby Aviation is to concentrate on aircraft and airship production and large GRP construction not related to offshore and underwater application. Slingsby Engineering intends to use its wide experience with underwater vehicles and equipment to grow into a product-orientated company.

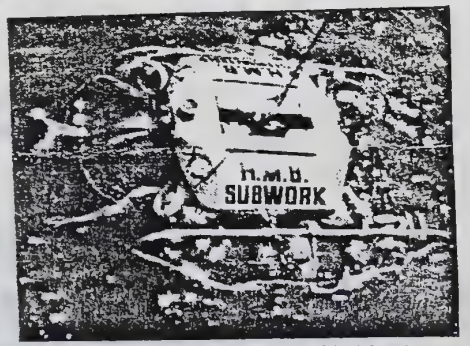
Already part of Slingsby's product line are master/slave manipulators suitable for rovs, underwater telephones which incorporate four frequencies, and the Spider, a manned, tethered, one-atmosphere submersible which can operate in depths up to 61m.

With safety an important factor in manned submersibles, Spider incorporates 72 hours of life support, emergency systems that operate following jettison of the umbilical cable, jettison capability of various equipment and a flotation unit for stability and support on the surface.

Mergers boost UK diving industry's resources

Two important mergers took place in the UK diving industry during November. Underwater Trials Limited, Fort William, has taken over the country's only saturation diving school, the Underwater Training Centre, while British Underwater Engineering has assumed overall management of HMB Subwork, the Mantis submersible operators.

The merger of UTL and UTC, with finance from an undisclosed source, gives the centre 'exactly the same facilities' as the prestigious government-backed Norwegian Underwater Technology Centre in Bergen, according to director Alan Broadhurst. Although the centre already owns the land and pier used by the diving base, it will now benefit by being able to use the saturation chambers and diving barges belonging to the school. The new Perry lock-out submersible for Shell's new multi-purpose support vessel, is currently undergoing tests at the centre.



The OSEL one-man submersible Mantis.

The saturation and air diving school will continue to function with more or less the same organisation as it had when it was owned by Shenley, the merchant banking subsidiary. Government grants from the Manpower Services Commission are no longer available, however. Ten students who recently began the £8,000, six-week course are all self-financed. In association with Paisley College, the school is also providing underwater ndt training to CSWIP standards.

The merger of HMB Subwork into BUE is superficially more surprising. HMB was set up in 1979 by a three man team to operate the Mantis submersible. The company now operates six of them worldwide, and after initial backing from American Express can claim to be the world's largest specialist operator in the field.

Although HMB will maintain its identity, it will effectively become the one-man submersible arm of BUE, which already covers submersibles and manipulators. 'It is a logical marriage', HMB managing director Peter Messervy told *OE*. 'We were fed up with a situation where we were winning contracts everywhere in the world except the British sector. We feel that the resources of a joint British consortium should stand a much better chance of putting Mantis into service with BP, Shell or Britoil'.

Since BUE took over most of the equipment sold off by the ailing Intersub, it has become almost a monopoly manned submersible operator in the North Sea. With the acquisition of HMB Subwork, it will be able to cover almost all submersible operations offshore and much onshore research and manufacture.

ROVs: new models facelifts for old

Deam Given's review of ROV builders and operators' activities in the past year shows the appearance of more new models and improved equipment suites for older ones. There are signs, however, that the coming year could see the growth curve flatten out

WITHOUT a doubt, 1981 was the peak year for the burgeoning ROV industry. Builders and users alike experienced sales success and growth beyond most market forecasts. In 1982, the bandwagon rolls on and at least four new robots are being offered for sale or lease and several of the established lines have received the familiar Detroit treatment for motorcars — new name, face lift and moderate change in performance.

The big news in the UK is the reincarnation of the Underwater Flying Observer (UFO). Originally designed by the now defunct Winn Technologies of Ireland, the UFO-300 series ROV has been redeveloped by OSEL Group and Submersible Television Surveys Ltd for North Sea sales and services, respectively. This is OSEL's initial foray into the unmanned world after scoring big wins with the Wasp and Mantis one-atmosphere diving systems.

The UFO is an observation and inspection vehicle, and it also can be equipped with NDT sensors. Quick descent to operating depths (2000ft max) is provided by means of a launching depressor and tether cable pay-out system. STS has two units available for service and OSEL has at least one more UFO under construction.

A major ROV manufacturer, International Submarine Engineering Ltd of Canada, has introduced its new RASCL, which has been designed as a low-cost (£25 000), observation and inspection system. Nominal depth rating is 1500ft. Three RASCL units have been built, two of which have been sold and are now in service. ISE has also modified its TROV and TREC systems with hydraulic, vice electric, power units as well as other component changes for greater reliability. These models have been renamed HYSUB and Mk-II, respectively.

Benthos, USA, an established supplier of ocean instrumentation equipment, has field tested its new RPV-430 inspection vehicle in the Canadian Arctic where it surveyed and photographed HMS *Breadalbane*, a three-masted supply ship which sank in 1853. The mission provided valuable information about long-term corrosion effects of Arctic waters. The RPV-430 is deployed from a launch cage and has a depth capability of 2000ft. An optional three-function manipulator has also been developed for the RPV which permits a light-work capability.

Another new ROV entry is the Operational Remote Control Apparatus (ORCA) from Aqua-Air Industries, USA. Operational to a 1000ft depth, ORCA is a basic TV survey and inspection system. Chief features are small size, good power and simplicity. Aqua-Air claims ORCA operators and technicians can be trained in an hour with maintenance as simple as replacing a circuit board. The company, a large supplier of diving equipment, predicts ORCA will capture a significant portion of the ROV market. But many veterans, who have seen long burn-in periods for new unmanned systems, are not as confident.

ECA, the French mass-producer of the PAP-104 mine neutralisation vehicle (about 200 sold), has introduced the POPE ROV. The acronym equates not to St Peter and his successors, but to 'fish in open water.' POPE No 1, a 450ft capable vehicle, has been sold to the French government; POPE No 2, now under construction, will be equipped with a deployment cage and will go down to 1200ft. ECA hopes to market it for oilfield support operations.

The remaining news thus far for 1982 includes a new SNURRE-2 ROV delivered to Intersub from Myren Sub Sea, Norway. This model differs from its SNURRE-1 brother with modular construction, a five-motion manipulator and provision for several optional equipments.

SCORPIO, the star performer of AMETEK/Straza, USA, now sprouts an additonal seven-motion manipulator. One SCORPIO, unit No 17 owned and operated by Oceaneering International, is equipped with the force-feedback arm developed by General Electric.

Lastly, Britain's Sub Sea Surveys' own-built IZE has been done up with a Straza Model 250A CTFM sonar, Photosea 35mm camera, low light TV, CP probe and other sensors all done up in a restyled buoyancy package and sonar dome. IZE has been a good performer for this ROV-only services firm.

A fast count shows about 160 or so ROVs currently available for offshore commercial use with perhaps another 70 in planning or under construction. The ROV curve which has spiralled upwards at a dizzying rate over the past five years will definitely begin to level off this year. This is influenced not only by the apparent saturation of the market but also by the current oil glut worldwide.

The significant question is whether these conditions are temporary or reflect writing on the wall. The view from this corner favours the former but just how long is 'temporary' is anyone's guess at this time. Insofar as the ROV market is concerned, 1982 should be a telling year. Survival of the fittest may be just ahead.

No Owner Surfaces To Claim Submarine

San Diego (AP) — The Navy, Coast Guard and harbor police are all looking for the owner of a 135-foot submarine found bobbing in San Diego Bay last week. Sat 3/5/83

Now docked at the 32nd Street Naval Station, the sub was found adrift Feb. 24, torn from its moorings by the recent storms that pummeled Southern California.

The Navy and harbor police want the sub moved, but the owner hasn't come forward to reclaim it.

EFCOM Relocates to New Facilities in California

EFCOM, Inc., formerly located in Irvine, California, has relocated to Santa Ana, California, and as a result has expanded its facilities to accommodate increased manufacturing demands.

In addition to relocating corporate headquarters, EFCOM has recently opened a regional office in New Orleans, Louisiana. Donald S. Berry has joined EFCOM as representative for the new office and will be covering the Gulf Coast Territory.

EFCOM, Inc., is primarily a manufacturing and research and development company in underwater communications and marking and relocating devices.

The company's new address is 1540 South Lyon Street, Santa Ana, California 92705, tel. (714) 543-0677, Telex: 683-423. The regional office is located at 4830 Church Street, Metairie, Louisiana 70001, tel. (504) 454-0198.

SUBMERSIBLE NEWS AND VIEWS

from IRENE FAGER

I have received a letter from CDR. Robert A. Killion, Chief Staff Officer, COMSUBDEVGRU ONE, and will quote for you.

"SEA CLIFF ceased to be a 6500 foot certified operational manned submersible in early April 1983 when she commenced conversion to her new 20,000 foot depth capability. Shortly after overhaul disassembly began, with some components in Mare Island Naval Shipyard, Vallejo, California, and the major (old) hull assembly still in San Diego, the Naval Sea Systems Command concluded that funding inadequacies would require the conversion be delayed. At this date, the shipyard and their Washington, D.C. managers are working to determine where the money will come from and when the conversion will be completed. Greater detail is not necessarily classified but is not generally spelled out - even to those of us who actually operate the vessel.

DSV TRIESTE II is underway today for training dives but probably will be retired by the time SEA CLIFF resumes operations."

WITNEY MACINNIS ENGINEERING LTD.
P.O. Box 360, Lions Bay, B.C., Canada V0N 2E0
(604) 921-9492

ONE HALF FATHOM
4004 Bay to Bay Blvd.
Tampa, Florida

Dear Irene,

After having read the April 1983 issue of One Half Fathom I felt that the following letter was in order with respect to the article released by IUC Canada (page 31).

During several of the years I was employed by International Hydrodynamics Co. Ltd (HYCO), I held the position of PISCES Project Engineer. PISCES VI, now owned and operated by IUC, was manufactured and tested by HYCO under my supervision as Project Engineer. I therefore feel it my responsibility to point out that the design depth of PISCES VI is 6600 feet and not 8600 feet as suggested by IUC. It is true, however, that the main hull is the best hull produced by HYCO as it is machined inside and out. It is also true that this hull is capable of withstanding pressures in excess of those found at the design depth of 6600 feet and could likely be certified for 8600 feet. However, as the design depth was 6600 feet, other vital systems are designed and tested to this depth. For example, the main hull viewports have a maximum rating of 6600 feet. As well, the high pressure water ballast system, portions of the emergency jettison system, penetrators, the two 32 inch diameter water ballast spheres, air systems, hydraulic systems, high pressure lines, valves and fittings etc. are all designed for 6600 feet.

In summary, the design depth of PISCES VI was 6600 feet and only 6600 feet. As it turned out, the main hull only proved to be capable of operating to greater depths.

Also, PISCES VI is not the deepest diving of the deep diving PISCES series. In 1979 I personally (with Mr. Tom Roberts) dove PISCES IV to her full rated diving depth of 6600 feet.

I trust that this sets the record straight. I am sure that IUC will do all that is required to ensure the safety of PISCES VI prior to diving in excess of 6600 feet, but once again the design depth was 6600 feet.

Yours truely,

John Witney

IUC Canada Offers *Pisces VI* Submersible Services

IUC Canada, with offices in Halifax, Calgary and Montreal, is offering for lease the *Pisces VI*, the deepest-diving Canadian built manned submersible, with design depth of 2,530 m. The sub, working in the waters offshore Newfoundland, has supported deepwater drilling to the depth of 1,486 m.

IUC Canada works in conjunction with Canamount Construction, Inc., a company with experience in marine construction, installation, repair and engineering.

In addition to the *Pisces VI*, IUC Canada has two Mantis one-man, one-atmosphere tethered submersibles, including the new model that can operate as a remotely-operated vehicle (ROV) and reportedly has 300% increased thrust. In addition, diving services from shallow-water through saturation capabilities are offered, as well as the services of ROVs.

For further information, contact IUC Canada in Halifax at (Main office) Halifax Insurance Building, 5670 Spring Garden Rd., Halifax, N.S., Canada B3J 3J1, tel. (902) 429-8110;

ALVIN still in a thousand pieces in our shop. The frame has been returned with modifications for the 'single-point pick-up' which will be required by A-II's "A" frame. ALVIN appearance will change slightly with a shorter sail. If everything goes back together according to schedule, ALVIN should start check-out dives about the middle of June with Navy certification and pilot training dives the first of July. We are in the process of training two new pilots and they should be certified by the Navy within a couple of months after operations restart. Presently, we only have Hollis and Nerolich piloting. At least twp science trips are scheduled out of Woods Hole in July and August with LULU as mother ship. Transfer to A-II will be mid-August if she is ready, with A-II/ALVIN sea trials commencing the beginning of September."

from Alan Whitfield. "Re: MANTIS 015..this vessel was leased by H.M.B. Subwork from Osel for a month to do a short job on the SEDCO 700 drilling rig. The new project I have joined is the Perry Mobile Diving Unit. It is a diver lockout submersible, which operates from the MSV THAROS. This is one of the major diving/fire fighting/rescue vessels in the North Sea. Diving operations take place around the clock and even in force 8 gales with no difficulties. Sixteen divers are stored in the saturation complex for operations down to 1000'. Plus we have a crew of 3 submersible pilots to pilot the MDU."

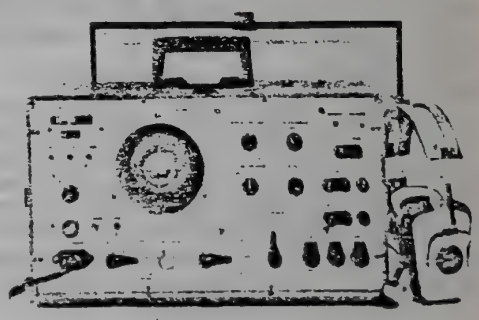
An interesting letter from Mr. Steve Etchemendy says, "I thought I'd drop you a note to tell you where I am now and what I'm doing. Graham Hawkes, the inventer of the WASP and MANTIS, has formed his own company, Deep Ocean Technology, and is producing a new one-man submersible named DEEP ROVER. I left Oceaneering and am now the Offshore Operations Manager for Deep Ocean Technology (DOT).

'The new sub is really going to be something special. We are selling the first one to Can Dive and it will be ready in early Fall. This first model will only have a working depth of 3,300 fsw, but we can produce a 10,000 fsw model right now if we have the demand.

'As well as the DEEP ROVER, we have built a remote controlled, guidewire deployed, manipulator system called the BANDIT. It's designed to support offshore drilling and is remarkable in its own right.

UNSCRAMBLERS USED TO SALVAGE RUSSIAN GOLD

Remember the massive salvage effort of a couple of years ago when $45 million in gold was removed from a ship sunk in World War II? The Edinburgh was en route from Russia to England when it was torpedoed by a Nazi sub in the Barents Sea. Many Allied lives were lost, as was a fortune in gold as payment for Lend-Lease Aid.



When Stuart Bain visited our San Diego facility recently, he reported seeing a TV documentary of that effort and spotting several Helle helium voice unscramblers in use. Stuart directs Underwater Video and Electronic Consultants in Australia. He is now assisting aboard the Shearwater Sapphire, a DSV operating off the Victorian coast. It has nine Helle unscramblers. Oh, yes. The Edinburgh remains in 800 feet of water with several million dollars of gold still aboard.

USG ROV BUYS

Several big ROV "buys" are in motion by the U.S. Navy and other U.S. government agencies.

• *Deep Ocean Cable Burial Vehicle.* The Civil Engineering Laboratory at Port Hueneme, CA have accepted bids on this ROV to bury bottom laid cables for depths up to 6,000 ft. We know of 2 old teams: (1) Lockheed Ocean Systems, AMETEK with a super SCARAB approach (i.e., powerful water jets to blast a trench for the cable) and (2) Honeywell Brown & Root with a traditional bottom sled/mechanical trencher method. Reportedly, there's nearly $10M for the winning team to produce an operational system.

• *ADROV.* The Naval Sea Systems Command, Washington, D.C., is evaluating bids on the Advanced Development ROV which is designed to be a small, lightweight (200 lbs. in air) ROV capable of identifying a threat target (mine) in 100m depths and carrying a payload (neutralization charge) to destroy that target. Bidders, reportedly, are: AMETEK/Interstate Electronics, Honeywell/HydroProducts and ISE. Wonder if NAVSEA knows that ECA, France has sold nearly 250 PAP-104 vehicles to western navies to do that very task. *SubNotes* got a copy of the NAVSEA spec. It weighs almost as much as a future ADROV!

• *Mine Neutralization System.* NAVSEA will ask for bids to *produce* this system, 14 or more in number. The advanced development model was built by the Naval Ocean Systems Center and engineering development model by Honeywell/Hydro Products. Bidders for the production aspect are not certain yet, but will certainly include Honeywell/HydroProducts.

Whether other bidders such as Lockheed, AMETEK, Bendix, Rockwell and others step up to the challenge is not known yet. Honeywell is certainly annoyed that production will go competitive. They point out that they are way up on the learning curve and the EDM system has passed stringent Navy tests. But 'sole-source' is not in the Navy's vocabulary these days.

DEEP-TECH BERGEN

June 1st was the launch date for a new cooperative group in deep-water technology. The five members of the group ar Bennex A/S, BMV Engineering, Chr. Michelsen Institute, Det Norske Veritas, and the Norwegian Underwater Technology Center, all of them well-known names in the offshore R & D and services scene, and all of them located in Bergen. Together, the members of Deep-Tech Bergen can make available several hundred experts in most aspects of advanced deep-water technology.

The idea behind the new technological constellation is that the expertise of these companies and institutes can be used most effectively in cooperation with the other members of the group. The Bergen region is already an important center for deep-water R&D and provision of goods and services. It is important for local sources of expertise to present a united marketing front when dealing with major international oil companies. Deep-Tech Bergen will also act as an interface between the oil companies and industrial firms in the Bergen region.

Deep-Tech Bergen will be coordinated from a secretariat maintained in the first instance by Bennex. The members of the group will continue to act individually in their own fields, but will be able to call upon each other's resources when opportunities occur for cooperation in major offshore projects.

BOL SUBS TO BE TETHERED

British Oceanics Ltd. (BOL) plans tests this year on an umbilical power supply designed for use with both observation and diver lockout submersibles. The goal is to certify the concept and have a commercial system operational by 1984. The umbilical will be designed to overcome manned subs' principle limitation of battery power. When applied to diver lock-out operations, BOL expects this type of system will compete aggressively with alternate diving systems.

SUTEC NEWS

- SUTEC is now completing the final tests for their Sea Owl Mark II, which has made 1 knot of speed against a 3 knot current with its umbilical cable fully extended.
- SUTEC is also in its final testing phase for a new, highly accurate hydroacoustic navigation system (accurate to within 1/10 of a degree) which enables precise search patterns to be setup on the sea floor.
- SUTEC has just finished testing the world's first solid state digital compass with no moving parts.
- SUTEC is now testing a very small TV camera (1¼" × 4") which is to be attached to the end of a manipulator for precision underwater work.
- SUTEC has recently sold 6 Sea Owls to Stolt Nielsen Diving, with an option on 4 more units, 4 units to the Swedish Navy and 4 units to the Norwegian Navy for counter submarine measures

ISE GULF NEWS

ISE GULF has just completed two RASCL ROVs (# 3 & 4) for Oceonics Lease Services in Aberdeen. The RASCLs were delivered in the first part of May. One is leased for use in the Middle East and the other is available for lease in the Gulf coast from Seatronics.

RASCL #1, owned by J.J. Olsen of Vancouver, has recovered over 250 tons of salvageable equipment. RASCL #2 has recently been purchased by Martech. The RASCLs are currently being built in Houston. The complete system includes vehicle, console, and 500 feet of umbilical. Price is $50,000 per RASCL.

• ISE has completed the Dual Hydra 2501 deepwater ROV system for Solus Ocean Systems, Inc. (SOSI). On May 6th, it was dived to 8,200 ft. (2500m) and functional tests were conducted using both a single coax and a fiber optic link in the special 10,000 ft. umbilical. Dual Hydra 2501 has an operating depth of 2500m and is the industry's first deepwater real time remote work system. This compact, powerful, dual manipulator system incorporates fiber optics, single coax data, video, and sonar transmission links, electronically scanned sonar, and acoustic hydrophones in its extensive suites of subsystems and capabilities. The 2501 is presently undergoing final integration and will complete its deepwater operational testing program in late May prior to a 1 June mobilization.

THE WESTINGHOUSE-BUILT STSS has completed a series of sea trials off San Diego. The Surface Towed Search System consists of a long (14 ft.) towed body fitted with side scan sonar, TV and photo camera, motion-compensated towing and handling crane and topside controls and displays. Owned and operated by the U.S. Navy's Submarine Development Group One, the STSS can be operated to depths of 20,000 ft. It will be used for search and location of aircraft, weapons and other valuable equipment lost at sea.

During its trials aboard the *Energy Service-1*, the STSS "found" the *USS Sabalo*, an intentionally scuttled World War II submarine, in 4,000 ft. of water. The towed vehicle portion of the STSS was displayed at ROV '83.

HYDROSTAR COMPLETES FIRST JOB

Honeywell's new HydroStar subsea tracking and relocation system has completed a one-month field trial off Honolulu, Hawaii in cooperation with the University of Hawaii Undersea Research Lab. The new system was used to track the submersible *Makali'i* during actual research operations. The sub was deployed from the vessel *Holokai* to take samples and underwater photographs off the coast of Oahu. The HydroStar tracked the *Makali'i* during 5 dives at depths from 250 to 1,200 ft. The system performed to specifications during the 1-month program. Undersea Research Lab users commented on HydroStar's reliable performance and easy operation. The first of these new HydroStar systems was purchased by Taylor Diving. Eight more systems have been sold for delivery in the Gulf of Mexico and the North Sea.

THE RETURN OF THE KAMIKAZE

BY **John Westwood**
Sub Sea Surveys, Ltd.

One of the most profound statements I have encountered in recent years came from **Sid Freeman** of BP, Aberdeen. "The problem with working underwater is that people find it fun and therefore are unable to make an objective assessment of the problems".

This to me totally describes the ROV business.

Throughout industrial history the greatest changes have usually been associated with the replacement of man by machine. The resultant economies and technical advances have often resulted in the development of totally new markets and the rise of new industries to work them. Such is the case with the Remotely Operated Underwater Vehicle.

A period of less than ten years has seen the new industry of ROV manufacturing and operation move through conception, birth and growth, and, if only in market terms, it has reached maturity. A measure of business activity in ROV's was the recent ROV '83 Conference held in San Diego when over 1,200 delegates attended from 21 different countries.

The capabilities of the ROV to carry to carry out high specifications pipeline inspection work, support drilling operations as a Diver alternative and beyond Diver depths, do certain structural inspection, survey the seabed, etc., has now become accepted throughout the offshore oil industry.

This gradual acceptance has resulted in such companies as I.S.E. of Vancouver and the California based Hydro Products and Ametek companies to build increasing amounts of their successful vehicles, and dependent upon who you believe, between 350 - 500 machines are now in operation (inclusive of military deliveries).

In late 1982 production lagged demand to a point where people were buying and selling ROV delivery options. However, wherever there is a market someone will fill it (hence Whores!). The ROV business is now reaching over supply in most categories, with even the most established manufacturers discounting.

In general much is written on the technical content of ROVs and their operation but the commercial reality is largely ignored. The most authoritative recent document on the ROV business *Underwater Vehicle Market* – February, 1983, produced by the UK Group Petrodata, states that "if allowed to develop the over supply situation will be serious for contractors who based their investment calculations on 150 - 200 days work per year. It will mean reduced utilization and profit which could lead to hardship with no immediate signs of relief."

Undoubtedly, this over supply was, and is, a function of companies bidding "below cost" to "get into the market" and "grab the biggest market share" regardless, and "offering ROVs as the loss leader to get lucrative diving contracts".

But as some of the more 'long in the tooth' veterans of the North Sea can recall we've been around this loop before with manned submersibles. "The Submersible Market can be called the 'Kamikaze Market".

Between 1971 and 1981 over "£60 M (US $120 M) had been invested in new technology and equipment by six companies and all six have either gone bust or discontinued the business" – (David Owen 1981).

These companies ranged from established industrial heavyweights like Vickers and P & O to the last to fall the French Intersub.

The manned submersible operating business had been built on the back of a North Sea construction boom which apparently none of the participants or their bankers realized.

Now we see some simularities to the present developing ROV over supply with a massive growth in part fired by the drilling boom. But drilling witnessed a rapid application of the brakes in 1982. Although not directly related it is interesting to draw a graph of growth of ROVs against increase in oil price – they are almost identical. The new technology of ROVs was introduced on a rising market for oil, that market has now 'stabilized' (I think that's the polite word).

In the final analysis capital invested in ROVs has to be serviced, this can only be realized by achieving sensible day rates in the market place. And this fact is going to be realized sooner or later by everybody, including those who are already large enough to know better!

Technically, there are many existing developments now underway (and there are a lot of red herrings floating around –just how do you get the autonomous ROV back on board if the power dies in Sea State 8?). No machine will ever replace man underwater but the ROV has now developed its own market areas where the Diver cannot compete, and is slowly inching its way into the activities once thought exclusive to (and highly profitable for) the Diver.

Considerable advances have been made in the primary areas of underwater viewing (with the British Company Osprey arguably leading the field) and ROV reliability.

Manipulator systems have advanced in cost effectiveness with such developments as the Slingsby Engineering TA009 Master Slave Feedback Unit.

In the area of very deep water work several ROV manufacturers and operators are making great advances.

It is probably reasonable to say that the ROV business does not have major technical problems – only commercial ones!

In a world where anybody can go buy an ROV it is the quality of the personnel operating them, the ability of their company to stay in business and delivering the quality of results the oil company is prepared to pay for that is going to matter.

John Westwood, Director and one of the Founders of Sub Sea Surveys, is responsible for many papers on the operations and technology of ROVs. Sub Sea Surveys have been in the forefront of North Sea ROV operations since 1977. Their well known CONSUB 2 ROV has surveyed over 2,000 Km of North Sea pipelines to date.

The company also operates a range of ROVs which are presently employed in South America, South East Asia and the North Sea. Sub Sea Surveys is a Member Company of the British Underwater Engineering Group.

NAVAL SUBMARINE LEAGUE

The U.S. Naval Submarine League has formed and is open to all who are U.S. citizens and want to support a strong submarine force. The league has incorporated in the state of Virginia and regional chapters are planned. It is governed by an 8-member board of directors headed up by **Admiral Al Whittle** (ret). The league will also publish quarterly the *Submarine Review*. Articles on specific submarine areas of interest, e.g., tactics, people problems and solutions, directions in R &D, lessons, submarine vignettes, are welcomed. Members can join individually or by company name. Annual dues are $10 for military active duty; $20 for all others. Donors/corporate contributions are *Founder* - $1,000, *Plank-Owner* - $500; *Skipper* - $100; *Advisor* - $50.00. Please contact the Naval Submarine League at P.O. Box 240, Mt. Vernon, VA 22121.

INNERSPACE THRUSTERS now come with *automatically tilting screens* which eliminate the obstruction of the propulsion jet by fixed screens. Also, the particular type of fine turbulence produced by the inlet screen results in a 5% increase in thrust for the same shaft power, or an 8% increase in effective power. The reason for this can be traced to the beneficial effects known to be provided by stream turbulence in suppressing varying degrees of flow separation.

Invented by **Cal Gongwer**, one of the world's premier hydrodynamic specialists, Innerpace Thrusters are used on all AMETEK ROVs, Perry RECON IV and the British Royal Navy's TUMS vehicle. Contact Innerspace at 19017 E. Leadora Ave., Glendora, CA 91740. Tel: (213) 335-2537 or 966-2228.

Two recent underwater engineering conferences, one in Aberdeen and the other in Paris, indicated the vitality of a young industry which owes its current strengths to the huge market for routine inspection of northern North Sea structures. Despite the recession, fresh research is being commissioned with at least two major closed cycle submersibles coming off the drawing board. Bart Milner assesses the likely future demands on the industry.

Buoyant days for diving

Despite the recession, the North Sea diving industry is remarkably cheerful to judge from two of this winter's conferences — the Association of Offshore Diving Contractors' (AODC) symposium in Aberdeen and the Association Technique Maritime et Aeronautique (ATMA) conference in Paris. At both venues it was clear that the North Sea now contains enough large structures requiring extensive statutory structural inspection to keep the industry buoyant.

Much of this work goes unpublicised and the operators are understandably unenthusiastic about drawing attention to the burdens of offshore inspection, maintenance and repair (imr). But feats of underwater engineering multiply, technical innovations are frequent, and the divers themselves are often aware of being pioneers on a frontier which catches the public's imagination.

André Galerne, of International Underwater Contractors, New York told the ATMA delegates: 'I would love to have lived in the days of buccaneers and explorers . . . and I would love to be in the ocean today, working on a bop (blowout prevention stack) at 300m, locking out and fighting the cold and current and time'.

There is ample evidence of new standards of engineering integrity underwater, work enforced by national laws and the diving inspectorates of Det norske Veritas and the UK Department of Energy (DoE), often based on the standards of the two navies.

Often criticised when they were introduced, these standards are now not only accepted and endorsed by the operators themselves, but there are strong signs that they are increasingly being used around the world. Shell demands Lloyds' standards underwater from Brunei to Gabon. Oceaneering is known to be keen to see similar standards applied to some of the older platforms in the Gulf of Mexico which have gained a reputation for rather dubious structural integrity. High interest rates and better reservoir engineering keep many older platforms functioning after the end of a design life drawn up before the 1974 oil price hike. Inevitably this creates more work for the divers.

Clearly few operators will welcome the large costs of frequent inspection at saturation depths, particularly if downtime is required and the platform's production/cash flow has to be halted. But different priorities seem to be evolving, and the *Alexander Kielland* disaster brought home to the industry the critical issue of offshore structural integrity. Diving safety standards are now thought to be higher than on many onshore construction sites.

A recent example of a North Sea operator committing itself firmly to diving imr is the £2 million diving spread ordered by Chevron for the Ninian Central platform. This sum covers only the initial stage of installation, and running costs for saturation spreads are never cheap.

The purpose of the spread is to inspect about 65m of risers previously viewed only by an rov, and to collect debris from around the J-tubes. Circular guide rails fabricated by Cromarty Firth are currently being installed by Interweld (Great Yarmouth). The bell, or a safety spare will lock onto the saturation chamber, for diver-transfer and then be attached to the mobile trolley, which will move around the circular rail system and dock above the work site.

The system capitalises on Ninian Central's circular design to give the bell and divers 360° access to the structure. This should get over the traditional difficulty — the restricted mobility and access of the diving bell — with platform spreads. It will be interesting to see whether other operators with steel jackets to inspect are able to follow Chevron's lead.

There is clearly enough revenue to make innovations in diving practice and, perhaps more surprisingly, in underwater research. One of the senior oil company delegates to AODC stressed that the current recession was no more than a lull and the diving industry should use the time to gear up for the next major phase of offshore work.

Some of the major research programmes underway are decidedly futuristic in scope if not in detail. James McFarlane of International Submarine Engineering suggests there is a gap in the market for an rov 'weighing 10,000kg, fitted with a 200hp propulsion system and manipulators which can handle loads of one tonne. The umbilical could be designed to have a breaking strength of 75-100,000kg so that large loads could be raised from the bottom directly'.

McFarlane may well be thinking of seabed mining as one use for such a vehicle. Arthur Markel of Reynolds Aluminium is similarly pre-occupied by seabed materials. Reynolds has re-activated *Aluminaut*, . . . 'the world's only aluminium submarine, designed to dive to 5,000m, is being readied to perform detailed bottom investigations at various deepsea (mineral) spreading centres located at depths between 2,000m and 3,000m'. *Aluminaut* is a six-man, silver-zinc battery powered submersible laid up since 1972 because of lack of commercial incentives. The craft is now being substantially re-modified to investigate the

Galapagos mineral chimneys discovered by Dr Alexander Malahoff of the National Oceanographic and Atmospheric Agency (NOAA) using *Alvin* in 1981.

Comparable in scale is *Argyronète* from Comex, Marseilles (see *OE* April 1982), a project whose original conception was far ahead of available technology but is 'now feasible because of recent developments in the field of compact and high-capacity autonomous power sources', according to Henri Delauze of Comex. Always strong on R&D, the company wants to use the 250t vessel in 1985 as a vast subsea laboratory. The original design is being simplified to cope with this.

If power was the problem for *Argyronète*, successful testing of the Phoenix 1350 by Sub Sea Oil Services of Milan could point the way forward. Backed by Micoperi, this 25t, four-diver mini-sub is claimed to be capable of 20 hours self-support over a range of 460km and carried a 90hp closed cycle diesel engine.

As scientific projects these initiatives are very significant. As tools for offshore maintenance, they may prove more limited. One Paris delegate from Britoil was worried that the bottom line of costs per hour might well favour topside-supported divers rather than lock-out submersibles.

C F Lafferty of BP International Underwater Services told the Aberdeen conference that if an experienced specialist needs to inspect a subsea installation personally, 'a mobile bell or manned submersible must be prescribed'. Otherwise 'there has been a retraction in the market for manned submersibles over the last three years but a large expansion in the atmospheric diving suit (ads) and rov market', particularly in exploration drilling support with operators satisfied with the performance of both types of system.

Keith Bentley of Phillips has another view, arguing that experienced pilots 'claim that the one-atmosphere bell (such as Comex MOB or Oceaneering ARMS) is the best and most effective work platform to date, within drilling support operations . . . if these systems had been marketed more aggressively we might have seen a different picture unfold'.

As far as UK research goes, Doug Hampson of OSEL is leading the field of tethered submersibles with the current construction of the deep-water *Hawk*, the five-knot *Dragonfly* and the two-man, 1,000m rated *Janus* concepts.

AODC delegates in Aberdeen expressed interest in the West German ZF-Herion-Systemtechnik *David*, a diver support and power supply system about to enter service for Scandive in Stavanger (see *OE* December 1982). One delegate was concerned that pricing might restrict availability of the vehicle. Another piece of solid German research is *Medusa*, a 600m depth rated rov designed for very long cruises. Produced by Profiline and Ocean Consult, *Medusa* is intended for track survey and pipeline inspection with power fed through a thin tri-axial cable and a new type of vacuum closure for connection of different payloads.

One major research project initiated in the US is the Woods Hole Oceanographic Institution *Argo/Jason* dual vehicle system. The idea is to differentiate between general survey and precise inspection, with *Argo* behaving as a sonar/tv carrying a wide-view towed vehicle but also acting as a garage for *Jason* to be deployed to collect more detailed information, through stereo colour tv and mechanical arms.

Brantner & Associates Relocates Headquarters

Brantner & Associates, Inc., manufacturers of Sea Con® underwater electrical connectors and cable systems, has moved its corporate headquarters and manufacturing facilities to El Cajon, California. The new 18,000 sq. ft. building will allow continuation of present operations, service, and deliveries, while allowing for expansion of research and development capabilities.

The new facility is located at 1240 Vernon Way, El Cajon, CA. 92020; telephone (619) 562-7070 in California (800) 854-2552 in continental USA.

SUPER EPAULARD, or Epaulard 2, is under development at CNEXO, the French Institution for Ocean Research & Exploration. CNEXO has commissioned a study with ECA (builders of Epaulard 1) and Safare Crouzet (for acoustic command & control link). The Super "E" will probably be again designed for a 6,000m operational depth, will have a vertical thruster (acoustically controlled), side look sonar (range 500m, resolution to 1m) and real time transmission of sonar. CNEXO is extremely encouraged by the successful performance of Epaulard and wants to add these improvements. As **Andre Galerne** commented at the UNH symposium on UROVs, "Let's hope the French don't ruin a good thing by making a simple reliable design into a complex, unreliable system." We concur but agree that the Epaulard design needs these improvements to serve a more useful purpose to man.

IUC EXPANDS U.S. WEST COAST OPERATIONS with basing of its Aloha support vessel in Santa Barbara. In addition to divers, IUC has its Mermaid manned sub available in July, a RECON-IV ROV from Perry.

At the recent untethered ROV symposium in New Hampshire, IUC PREXY, **Andre Galerne** brought the house down with his remark while introducing his brief on IUC & Epaulard. After sitting through several highly technical and theoretical presentations, Andre offered that he "may be the least intelligent person here – but also maybe the richer." Incidentally, his presentation was excellent because he brought the audience into the real world of offshore rigors and requirements. Featured during his talk was an impressive video tape in color of the Epaulard operations off San Diego last month. The tape was provided courtesy of NOSC, San Diego and is narrated by **Norm Estabrook**, NOSC, who coordinated the Epaulard demo. Recommended viewing.

IMO's New Distress System Taking Shape

By Jack Fuechsel
National Ocean Industries Association

The maritime telecommunications community will be hearing more and more about the Future Global Maritime Distress and Safety System (sometimes referred to as FGMDSS).

IMO is the International Maritime Organization, a specialized agency of the United Nations headquartered in London and formerly known as IMCO. IMO's Radiocommunications Subcommittee has been working for several years on a major overhaul of the maritime distress system. In fact, it was a major maritime disaster, the sinking of the *Titanic*, which led to IMO's original Safety of Life at Sea Convention.

This convention is the fundamental IMO treaty and describes the "Marconi style" radio distress system which continues in use today virtually unchanged. This is not to say that it deserves to have remained unchanged; the very traditional maritime community has been very slow to adapt to modern technology and this overhaul is long overdue. (Presumably at an appropriate date the "F" will be dropped from FGMDSS.)

The new system has many highly commendable features and deserves to be implemented as rapidly as possible. The stage should be set before describing these features. First of all, the new equipment carriage requirements will only apply to "Convention" ships—those over 300 gross tons on international voyages. Even though IMO sets some requirements for vessels down to 300 tons, it is traditionally a large ship forum and most of the radio requirements in the past have been for the so-called "radiotelegraph" ships over 1600 tons which are required to carry radio operators. Cargo ships of 300 to 1600 tons are permitted to have simple radiotelephone installations and are not required to carry radio operators.

This traditional 1600 ton break point is currently an unresolved issue. While agreement was reached on the basic FGMDSS requirements for ships above 1600 tons, they still have to be resolved for ships between 300 and 1600 tons. The National Ocean Industries Association (NOIA) represents many of these smaller vessels which are engaged in offshore operations and is participating actively in an effort to arrive at scaled-down requirements which are realistic for smaller vessels. It is important to the success of the overall system that these vessels be included, but it is necessary that the requirements be realistic so that they are not economically burdensome. In the following paragraphs which describe the basic system, those requirements for small vessels which NOIA is proposing to modify will be indicated.

"The new distress system is a major event in maritime safety and should have a dramatic effect in improving the saving of life and property at sea."

Certainly the new maritime satellite communications system will be one of the primary elements in the new system. The short title for this system is INMARSAT which is also the organizational title of its operating agency, the International Maritime Satellite Organization. This system will generally replace the old high frequency radio systems with high quality, automated, voice, teletype and data communications.

It is not a complete answer however, since the terminal, which requires a stabilized tracking antenna, is too bulky and expensive for small ships. An additional factor is that INMARSAT coverage, while comprehensive, is not complete; there is no coverage above about 70 degrees latitude and a gap in the eastern Pacific.

Digital Selective Calling (DSC) is another fundamental feature which would be required in the new system. INMARSAT uses its own version of DSC in order to obtain the automation referred to earlier. The intent is to apply a similar technique to more conventional forms of maritime communications.

The principal advantages of DSC lie in reliability and increased range for alerting, etc. Practical benefits will enable watches to be maintained without the distraction of having a speaker blaring in the background constantly (or the more likely situation where the volume has been turned down to avoid the distraction and an effective watch is not being maintained). DSC would be set up to alert the operator whenever a call has been addressed to his ship or an emergency call has been sent to all ships.

Perhaps the most dramatic piece of hardware is the new Satellite EPIRB (Emergency Position Indicating Radio Beacon). There are

hundreds of EPIRBs in use today, primarily on aeronautical emergency frequencies, and they have made a great contribution to safety. These conventional EPIRBs are more effective in areas of frequent overflight. The newer Satellite EPIRBs have the advantage of highly reliable detection along with position determination.

We will probably see deployment of two complementary systems: geostationary satellites (such as INMARSAT) for instant alerting and polar orbiting satellites for position determination and to fill in the polar area coverage. It is expected that this new generation of satellite EPIRBs will be vastly more effective due to modern technology and because they will be designed to float free and activate automatically in event of a catastrophic sinking (For more on satellite EPIRBs, see also page 25).

You have probably seen press coverage of several dramatic rescues facilitated by an experimental Russian satellite designed for this purpose (and recently joined in space by a counterpart U.S. satellite). Even though the cost of such a system will be substantial it can serve land and aeronautical users as well. The cost of new EPIRBs is still unknown but could be on the order of $3,000-$5,000. NOIA is recommending a simplified satellite EPIRB for the smaller ships to keep costs within bounds.

Narrow Band Direct Printing radioteletype (NDBP) is proposed as a common capability for most ships. This is not a great departure from the current state of the art except to require the capability for standardization. NOIA has recommended that this requirement be waived for vessels below 1600 tons.

A new system for the broadcast of marine information which is highly automated will be introduced. It is in use today in northern Europe and it is usually referred to as the NAVTEX system. The information is broadcast on 518 kHz and is received aboard ship on a receive-only NDBP printer.

The system is programmed to copy a particular broadcast only one time and will not repeat subsequent rebroadcasts of that notice. While this system has great promise for transient ships, it is less needed by the smaller vessels and NOIA is recommending that it be optional for vessels below 1600 tons.

There is a new requirement that vessels be equipped to transmit homing signals as an aid to vessels trying to locate them in an emergency. There is also a counterpart requirement that all vessels be equipped with a homing device to locate such signals. The frequency for these operations has not been firmly established but will probably be in the marine VHF band. Large ships have been required to have direction finders in the past but small ships have not; NOIA is therefore recommending that homing equipment be optional for vessels below 1600 tons.

There is an "Area of Operations" concept which modifies equipment carriage requirements based on the distance from shore facilities. Area A-1 is within VHF coverage range from shore stations and thus has greatly reduced requirements. Area A-2 is within medium frequency range, typically 160 km (100 miles), and does not require high frequency or satellite capability.

Area A-3 is within INMARSAT coverage areas and requires either INMARSAT or a full high frequency capability. Area A-4 is high seas outside INMARSAT coverage and relies on high frequency capability. NOIA is not recommending any modifications to the area of operations concept except to note that many vessels below 1600 tons routinely operate within 320 km (200 miles) of the coast and would be adequately served with medium frequency equipment augmented with 4 and 6 MHz high frequencies.

What happens to the conventional distress system based on manual Morse telegraphy at 500 kHz? This would be maintained during the overlap period until FGMDSS is fully implemented and would then disappear. The Radiotelephone distress frequency, 2182 kHz, would remain for voice medium frequency emergencies as would the VHF-FM distress frequency 156.8 MHz in that band.

EXPANSION

Oceaneering International has established a second support base for its Jim and Wasp atmospheric diving suits (ads). Western hemisphere ads support will now be based in Santa Barbara, California, and eastern hemisphere operations will be handled from Aberdeen, which was previously the worldwide support centre.

Lockheed Shipbuilding Expands And Adopts New Name—Lockheed Marine

Lockheed Marine has become the new name for a long-respected company with a worldwide reputation for excellent shipbuilding.

Lockheed Marine, with headquarters in Seattle, Wash., now encompasses the former Ocean Systems group that had been part of Lockheed Missiles & Space Company of Sunnyvale, Calif. Under its new banner, Lockheed Marine will now consist of two divisions—the Shipbuilding Division in Seattle, and the Advanced Marine Systems Division with operations at two San Diego locations as well as at Santa Clara, San Jose, and Sunnyvale.

By combining the high technology capabilities of the Advanced Marine Systems Division with the strengths of the Shipbuilding Division, Lockheed will enhance its position as one of the leaders in the field of marine systems. The Advanced Marine Systems Division activities will remain at its California locations, but will report administratively and functionally to the parent Lockheed Marine headquarters in Seattle.

Approximately 500 Advanced Marine Systems Division personnel based in California are affected by this consolidation announced at Lockheed Corporation's Burbank, Calif., headquarters. No transfer of personnel to or from Seattle or California is planned.

The Advanced Marine Systems Division activities include deep submergence rescue vehicles, mine neutralization technology, unmanned Navy test vehicles, hydrodynamic research, marine corrosion protection systems, ocean science, ocean mining, naval architecture, marine engineering, and other marine-related high technology endeavors.

Surface handling for Mantis

Canadian Offshore Systems Engineering (COSEL) has been awarded a contract to manufacture the surface handling systems for four new Mantis submersibles. The systems are to be delivered to K D Marine and Scandive for installation on the Bowdrill 2 and 3 later this year.

A Seven Year Itch to Grow

University of Southern California's Institute of Marine and Coastal Studies

By Larry L. Booda
Editor

Los Angeles, California—From the mid-1950s until 1975 oceanographic research, with a few exceptions, was low key at the University of Southern California (USC). That prestigious private school, located a short distance south of the city center here, has had internationally known marine researchers and professors on its staff. In the main, however, the major academic disciplines operated their marine programs independently with minimal central coordination.

The notion of providing a better framework for marine research came when the hierarchy of the university, a completely new team, created a faculty task force in 1972 to study how better to organize and administer that research.

The group made its report in 1974, recommending an organizational change built around an institute, whose head was to be given the title of director, the equivalent of the dean of an academic school. The task force's recommendations were accepted.

In order to form an institute the first task was to find a director. A search committee went to work, looking over the credentials of 30 candidates. As the selection process progressed, the finalists were interviewed. One of those interviewed was a U.S. Navy Captain, Don Walsh, who was graduated from the U.S. Naval Academy in 1954. Walsh, who had wanted to become a Naval Aviator but was prevented because of his eyesight, opted instead for submarine duty.

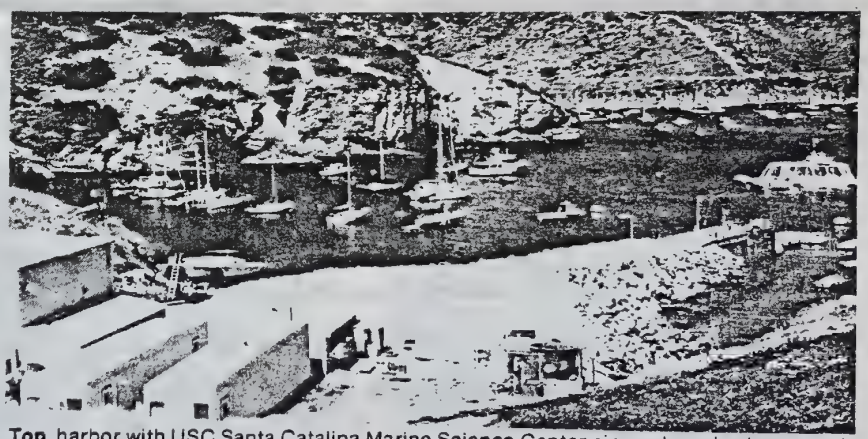
To understand why Walsh was chosen as first director of the USC Institute of Marine and Coastal Studies (IMCS), more detail on his career must be revealed. After the usual junior officer tours of duty he became interested in deep submergence, a path that led him to a modicum of fame and a permanent place in the Guinness Book of World Records.

In 1958 the U.S. Navy purchased the bathyscaph *Trieste* from the Swiss inventor Auguste Piccard. A series of dives showed that the submersible could go ever deeper. Those dives were performed by Dr. Andreas Rechnitzer, now on the staff of the Oceanographer of the Navy, Larry Shumaker, now with Interstate Electronics Corp., Walsh, and Jacques Piccard, son of Auguste.

By late 1959 the *Trieste* was ready to penetrate the deepest spot in the ocean, the Challenger Deep of the Marianas Trench in the Pacific Ocean east of Guam. Walsh and Piccard went to the bottom January 23, 1960, 10,910 meters (35,800 feet) down, entering a record in the books that can never be broken, only equaled.

Walsh, not yet senior enough for a deep draft command, applied in the early 1960s for permission to take graduate work in oceanography. His request was granted, but there was no provision for paying his tuition. He was accepted at Texas A&M University. He paid for his advanced education by lectures nationwide. He earned his Ph.D. A gifted speaker, he continues to this day to lecture worldwide. Numerous times he has been sponsored by the Department of State and has given talks on oceanography in general aboard Royal Viking Lines cruise ships.

Walsh got his deep draft command



Top, harbor with USC Santa Catalina Marine Science Center pier, submarine hangar left. At far right is the kelp harvesting research project of the American Gas Association, California Institute of Technology and General Electric Company. **Bottom,** view from opposite direction with pier on left and new office building right background.

but then found that, qualified as a diesel submariner, he was stymied in becoming a flag officer in the age of nuclear power. He began considering ending his Navy career.

That was his status in 1975 when the university formally asked him to become director of the Institute. He accepted and in addition to the director's post, he was made a full professor in ocean engineering with tenure.

Accompanying Walsh was Captain Don Keach, also a submariner, ranking from 1951, who was appointed deputy director.

Rapid Growth

Marine studies at USC began in 1905 with courses in marine biology. In 1910 the program was expanded by the opening of a marine biological station at Venice, California. In the next year USC's first marine research craft was acquired, the *Anton Dohrn*.

Oceanographic research growth in the period to 1975 was non-uniform, varying up and down. Its major emphasis was on marine biology. The program existed on federal and state government grants, industry, foundations and individual donors. The first major individual donor to USC marine research was Captain Allan G. Hancock, who was affiliated from the late 1930s to 1954.

Costs of marine facilities rose and utilization declined. USC's Catalina Marine Science Center is on Santa Catalina Island. USC has a considerable interest in the island through an endowment by the Wrigley family. The Wrigley fortune was founded on the manufacture and marketing of chewing gum.

Federal funding for the research vessel *Velero IV* was in jepoardy and the Sea Grant program was in such a state that there was serious thought of terminating it. Teaching programs, except for geology and biology, lacked the depth and breadth of disciplines.

It was at this point that the Task Force on Marine Affairs was formed by USC vice president Kaprielan. It made its recommendations in 1974. Most of them were accepted.

IMCS Formed

Thus in September, 1975, IMCS came into being. In forming the Institute no funding was provided for pre-existing activities and no space was provided for them. Funds were made available only for the salaries of the director and his secretary. Placed under IMCS were:

- The Sea Grant Program.
- Catalina Marine Science Center.
- Research Vessel *Velero IV* and other small craft.
- Applied research projects of the Hancock Foundation.

At that time biology, geology and ocean engineering remained separate. As a sign of progress the first two are now under the Institute. Thus in its beginning IMCS had no students, no alumni and no authority over the existing academic program.

That is what Walsh faced in 1975. He is modest about progress since then.

It is a tribute to him that he was indefatigable in recruiting funds. Backed by the university he supervised a rise in endowments from $100,000 in 1976 to the $20 million range now. Of that $20 million $16 million is in cash, the rest in kind.

Some of the "kind" were private yachts donated by owners who couldn't or wouldn't pay the rising costs of fuel. Some of them have been sold for a total of $800.000, adding to the cash endowments.

Another "kind" is the Wrigley home in Avalon, Santa Catalina Island, on a hill overlooking the resort harbor. With houses along the harbor selling for between $300.000 and $400.000, one can only guess at the mansion's worth. It is now a conference center. Another gift was what was the Southwest Regional Oceanographic Equipment Calibration Laboratory of the National Oceanic and Atmospheric Administration (NOAA) in La Jolla, California, near the Scripps Institution of Oceanography.

Progress

In the first full year, 1976, contract research increased to $700.000, and the Harbors Research Laboratory was formed. This latter item reflects the coastal orientation of IMCS as compared to Scripps and the Woods Hole Oceanographic Institution which perform distant, ocean-wide research.

In that early period of IMCS Walsh recruited one widely known scholar and one not-so-well-known but technology-socio-politico researcher to be the initial members of his team.

One was Dr. Arvid Pardo, originally from Malta and an early participant in United Nations committees that addressed the updating of the 1958 sea treaties. He was the first person to state publicly in a U.N. Committee the credo that the seas are the common heritage of mankind. That theme was adopted by the general assembly.

That statement became the rallying cry of the so-called third world, or developing, nations in the Third U.N. Conference on Law of the Sea. It was further seized as the keystone of the new world economic order, a now popular theme among the developing nations in the U.N. It continues to be controversial.

In the sheltered atmosphere of the research and teaching world Pardo continues his studies, with his ideas now somewhat modified. He stands as a tribute to Walsh's objective approach to support of broad socio-politico ideas, even though he is basically a political conservative. (He was tempted twice by offers of support to run for political office.)

The other professional is Dr. Robert L. Friedheim, who came from the Navy sponsored Center for Naval Analyses. He has been the guiding hand in establishing the IMCS program for awarding Master of Marine Affairs degrees in Marine Transportation under the Institute's Center for Marine Transportation Studies.

Basically, the MMA candidates are trained in management of ocean and maritime enterprises. (Marine Affairs graduate degree programs originated at the University of Rhode Island under Dr. Lewis Alexander, now the geographer for the Department of State.)

Here is an idea of what courses the candidates take:

- Marine Transportation Systems.
- Economics of Marine Transportation.
- Naval Strategy and International Politics.
- Seaport Policy and Management.
- Ocean Law on Admiralty and Shipping Policy.
- Shipping Management for Liner

))) **President Declares Exclusive Economic Zone; Bills Introduced in Congress.** On Thursday, March 10 President Ronald Reagan issued a proclamation creating an Exclusive Economic Zone (EEZ) seaward from U.S. shores for 200 nautical miles. Within two hours of the long awaited action Sen. Ted Stevens (R-Alaska) introduced a bill in the Senate containing similar language and Rep. John B. Breaux (D-Louisiana) and Rep. Edwin B. Forsythe, Jr., (R-New Jersey) introduced an almost identical bill in the House of Representatives. Up until now the main U.S. laws governing the 200 mile zone were the Outer Continental Shelf Lands Act of 1953 and the Fisheries Conservation Management Act (FCMA) which dealt with all but migratory species of fish. Former President Harry S. Truman in 1945 claimed jurisdiction over the OCS lands. The proclamation extends the jurisdiction to the living and non-living natural resources of the seabed, subsoil and superadjacent waters beyond the territorial sea (3 miles). It includes rights over all minerals, such as manganese nodules and polymetallic sulphides in the zone that are not on the continental shelf, fairly recent discoveries in the EEZ. The waters affected are adjacent to the U.S., Commonwealth of Puerto Rico, Commonwealth of the Northern Marianas (consistent with the Covenant and U.N. Trusteeship Agreement) and U.S. overseas territories and possessions such as Guam, American Samoa, U.S. Virgin Islands, the extended Hawaiian chain, Johnston Island and Wake Island. Territory encompassed by the EEZ is estimated to exceed 2 million square miles. Important in the proclamation is the decision not to assert jurisdiction over marine scientific research in the EEZ. The intention is to promote maximum freedom to perform such research. Congress is expected to pass an EEZ bill into law with little opposition.

Practice code for subs out soon

THE WORLD'S first code of practice for the operation of manned submersibles will be published in the new year after year-long consultations by the Association of Offshore Diving Contractors (AODC).

The code, drafted by the submersible committee of the AODC, itself representing companies employing 95 per cent of the divers working on the north west European continental shelf, will be finalised in the new year after talks with the UK Department of Trade and the Norwegian Petroleum Directorate.

Up to now operators of manned submersibles enforced their own house rules which related to the specific jobs being undertaken at the time and there has been no overall formal code governing operating procedures. The code will deal with operating aspects including emergency procedures for all types of manned submersibles from one-man to multi-manned vehicles.

"We have said as the responsible body that this is something that we should do and AODC have been trying to put together the whole experience of submersible operators to form the code," said Mr. Tom Hollobone, Association Secretary.

The new code will have advisory status only but with approval from the Norwegian and British Government departments concerned as well as submersible operators through AODC it is expected to carry significant weight within the industry, he said.

For Your Information . . .

From: The Director, Division of Safety Research, National Institute for Occupational Safety and Health

The National Institute for Occupational Safety and Health (NIOSH) advises discontinuance of use of the Robertshaw RAM-5 combination 5-minute emergency escape self-contained breathing apparatus and supplied-air respirator (MSHA/NIOSH approval number TC-13F-64).

During audit testing of two RAM-5 respirators, NIOSH found a defect in each respirator, a defective hose in one and a free-flowing regulator in the other. Each problem resulted in shortened service time of the self-contained air supply. In view of the critical nature of these failures, this respirator should not be used until the necessary actions have been taken by the manufacturers to correct the problems.

Robertshaw and Life Support have agreed to discontinue sales and distribution of the RAM-5 respirators until the causes of the failures have been determined and any defective respirators have been recalled, retrofitted, and returned to the users in accordance with a NIOSH-approved plan.

All owners of the Robertshaw RAM-5 respirators should contact Robertshaw Controls Company (Norman Beaman, 333 North Euclid Way, Anaheim, California 92803, 714-535-8151) for further information.

How titanium can improve performance and survivability of modern naval vessels.

COMPARISON OF PROPERTIES

Property	Copper Nickel 90-10	Aluminum 5086	Steel HY-80	Titanium 6/4 Annealed
Ult. Tensile Strength - KSI	44	38	105	130
Density - Lbs./cu. in.	.32	.10	.28	.16
Tensile St./Density	137	380	375	812
0.2% Yield Strength - KSI	16	17	80	120
Modulus of Elast-KSI 10^3	18	10	29	16
Melting Point - °F	2100°	1050°	2700°	3000°
Thermal Expansion 10^{-6} in./in./°F	9.5	10	6	5.5
Ballistic Properties	Fair	Fair	Good	Excellent
Erosion Resistance	Fair	Poor	Fair*	Excellent
Corrosion Resistance	Good	Fair	Fair*	Excellent

*Coating Dependent

For the past three decades, titanium has shown outstanding performance as a structural material for naval aircraft. Despite this record, only a small portion of its potential has been used for naval vessels. Wider use of this unusual metal can improve the performance and survivability of both ships and submarines.

For example, titanium is stronger than commonly used HY-80 and HY-120 steels, yet weighs 45 percent less. Its strength-to-density ratio is superior to both steel and aluminum. It has excellent ballistic properties, having been used as armor plate on aircraft and helicopters. Its melting point is higher than other structural materials, and it maintains strength at higher temperatures. An added bonus is that titanium is completely resistant to corrosion by salt water.

A superstructure built largely of titanium would be light, strong, corrosion-resistant, and have excellent ballistic properties and resistance to flame. The result would be a surface vessel that is easier to maintain and is more stable and survivable.

Titanium can enable submarines to dive deeper with less chance of detection. Its depth capabilities have been shown by the deep diving research vessel ALVIN, which uses titanium alloys in its pressure hull, variable ballast system, buoyancy spheres, electrical penetrators, exostructural frame. Substitution of titanium for HY-100 steel in the pressure hull increased the vehicle's maximum operating depth from 6,000 to 12,000 feet with a higher payload. The Soviet Union has built a titanium submarine, the ALPHA class, which displaces 3,300 tons, has a submerged speed of 42 knots, and is reported to be able to dive to more than 3,000 feet. Since titanium is nonmagnetic, its chances of remaining undetected are improved.

Titanium equipment improves a vessel's performance and reliability. For example, titanium heat exchangers are lighter and more compact than those made of traditional copper alloys. They are immune to seawater corrosion, even at high velocities. So too are titanium valves and piping. Titanium's record of reliability has been proved in 100 million feet of TIMET tubing in surface condensers in power plants using seawater or cooling water containing chlorides, sulfides, and other corrodents. There have been no recorded failures of the titanium tubing from corrosion, or erosion.

Readily fabricated. Despite misconceptions, titanium can be easily welded in the field. Welds do not have to be heat treated to guarantee corrosion resistance. Titanium can also be safely and readily flame cut and ground.

Cost vs. long life. It is true that titanium has a higher first cost than steel or aluminum. However, this can be offset because titanium offers many economies in maintenance-free operation and longer operating life.

Plentiful. Titanium is the ninth most abundant element in the earth's crust and the fourth most abundant structural metal. The American continent alone has more than 300 years supply of titanium ore. There is a national defense stockpile. The titanium industry, now more than 33 years old, has a constantly growing production capacity and a network of skilled fabricators.

Using current technology, a wider use of titanium has the potential of improving naval vessels.

For more information, call or write TIMET, Dept. 1S, Box 2824 Pittsburgh, PA 15230; 412-262-4200.

TIMET *first in titanium*

Ship That Found The New World—Found at Last?

The project is snared in controversy, but an ancient wreck in the Caribbean is stirring hope that it may be Columbus's *Pinta*.

Has Christopher Columbus's long-lost ship, the *Pinta*, been found?

That is the question intriguing scholars in America and Europe as evidence piles up about the wreckage of an old ship—possibly the oldest ever found off America—located in the Caribbean. If it is the *Pinta*, the discovery would be one of the most significant finds in the history of maritime archaeology.

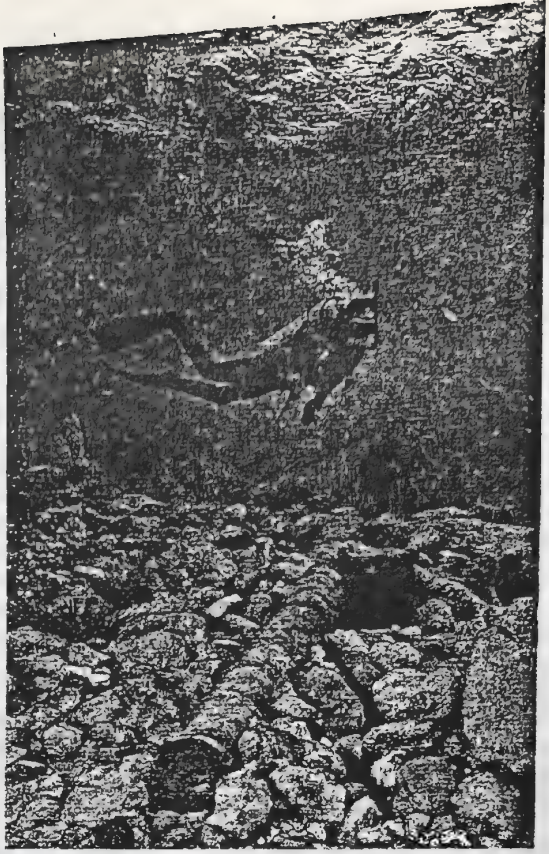
It was a sailor on the *Pinta*, traveling west from Spain with the *Niña* and the *Santa María*, who was first in the fleet to spot a fragment of the New World—an island in the Bahamas—at 2 a.m. on Oct. 12, 1492.

The history of the other two vessels is clear. The *Niña* was retired after long service, and the *Santa María* sank off Hispaniola, the island now containing Haiti and the Dominican Republic. But the *Pinta* dropped literally and figuratively out of sight when it was struck by a storm somewhere in the Caribbean on a voyage in 1500.

Unexpected find. In 1977, two treasure hunters from Florida, Olin Frick and John Gasque, were exploring the waters of Molasses Reef off the Turks and Caicos Islands between the Bahamas and the Dominican Republic when a strange X-shaped object on the bottom came into view.

"We were looking for Spanish treasure ships and knew there were wrecks around there," recalls Frick. "A diver picked up this piece, and it turned out to be two guns. I looked at them carefully and could tell they probably came from the late 1400s."

Frick, who has hunted for underseas treasures for 30 years, recognized that the antiquity of the guns set the wreck apart from the hundreds of ships that have gone to the bottom of the Caribbean since Europeans began venturing to the area in substantial numbers during the 1500s.



BOB WALLACE—TROPIC

Diver examines a cannon in ruins of a vessel that some experts believe is the remains of the *Pinta*.

"We did a lot of research and found that the *Pinta* was in the Bahamas at the right time," says Frick. "The shape is right, the size is right, the amount of ballast rock is right and the number of guns is right. We've also examined many of the materials found, and we're completely satisfied that this wreck is the *Pinta*."

Other specialists are not so sure. Kenneth Cassavoy, executive director of the Institute of Nautical Archaeology in Texas, says that "research has only just begun" and "the odds are very long against this ship being the *Pinta*."

The institute, affiliated with Texas A&M University, took over the task of recovering the wreck after the Turks and Caicos government put an end to earlier arrangements with Frick and others, partly because of delays and worries about how the work would be handled.

Patience needed. Making positive identification of the sunken vessel probably will not be accomplished anytime soon. Says Cassavoy: "Excavation is far from finished, and it will take a long time to examine what has been recovered."

Despite the questions that remain, many maritime scientists say they are convinced that the wreck is the oldest ever found in American waters, probably dating to about the first half of the 16th century.

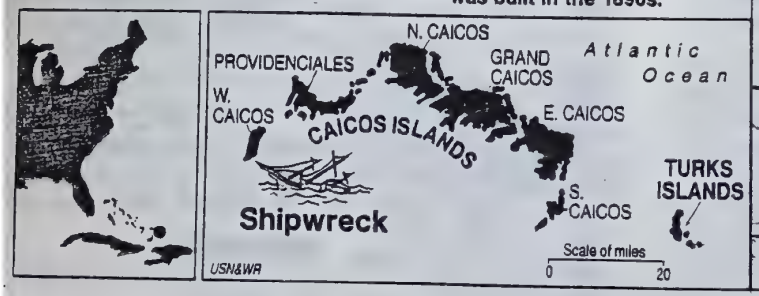
Work at the site recently ended for the summer, but examination of the recovered materials and research into maritime archives in America and Europe are continuing. Plans are to assemble the artifacts for public viewing on the islands.

Cassavoy insists, "It's an extremely important wreck. But scientists are generally cautious about matters like this. In fact, we may never know for certain if it's the *Pinta*." □

By WILLIAM L. MacDOUGALL

LIBRARY OF CONGRESS

Replica of the type of ship Columbus used in voyages was built in the 1890s.



Will Robots Replace Man in the Sea?

Soapbox

Sylvia A. Earle has a B.S. degree from Florida State University and M.A. and Ph.D degrees from Duke University, and has served as Fellow, Research Biologist, and Curator at the California Academy of Sciences, San Francisco, California, since 1976. Since 1980 she has been a member of the National Advisory Committee on Oceans and Atmosphere (NACOA) and presently chairs a panel on marine research and technology for that committee.

Listening to some oceanographers and others involved with the offshore oil industry one gets the impression that the ideal way to explore and work in the oceans will be to sit in an arm chair in Iowa, pushing buttons and watching television monitors while a mechanical device responds via satellite link to service oil rigs, mine the deep sea, and effectively explore the distant unknowns of the ocean all over the planet.

If this seems to be a wild science fiction fantasy, delete Iowa and the satellite link and the scenario is real and now. At the recent ROV '83 conference sponsored by the Marine Technology Society in San Diego, featured speaker Emory Kristof observed that "The kind of diving I do now is sitting in a deck chair while I operate a 'Pac-Man' joy stick."

Kristof, diver-photographer with the National Geographic Society, used a Benthos ROV to explore a shipwreck in Canadian waters with veteran underwater explorer Dr. Joseph MacInnis. Both found much to praise about the subsea robot. "It can go deeper, stay longer, and it's a lot more agile," said Kristof. MacInnis was more succinct: "That's it for the diver."

Scientists have made modest use of remotely operated vehicles thus far. Industry and military users presently own and operate the vast majority of subsea robotic systems. Their development and application has been rapid, starting in the early 1950s, with a growing crescendo that is far from reaching its peak.

In a 1979 survey made by Frank Busby, 156 remotely operated vehicles had thus far been developed including 12 tethered but free swimming, 17 bottom crawling, 17 towed, and 10 untethered systems. Busby's latest (heretofore unpublished) figures total 423 in the above categories worldwide, plus an additional 231 that are designed specifically for military use in mine neutralization. In all he has identified 53 distinctive designs, some one of a kind, some in multiples, while a few, such as Ametek Straza's Scorpio and Hydro Products RCV 225 number in the dozens.

One of the main justifications for putting man underwater is his ability to see. On other counts, a person sitting inside a pressurized submersible is nearly as remote from the actual outside environment as a man operating the controls of an ROV from the surface, thousands of feet away. Recently developed camera systems, light intensifiers, and other artificial sensing devices are helping to gather and effectively relay information to a human pilot, on-the-spot, inside a pressure hull, or on the surface.

Spatial correspondence that people take for granted is lacking in most ROV systems, and sensory capability and information transmittal varies widely. Some systems are little more than "flying eyeballs" while other are outfitted with a wide array of sophisticated gear.

Some ROVs are equipped with specialized tools, others with general purpose manipulators. One sensory manipulator system features hydrophone "ears", camera "eyes", a four-function hand, a sense of motion, force, touch, and 100 kg lift capability coupled with dexterity sufficiently and shape. Clearly, some manipulators and the machines that back them up can outperform human capability for certain kinds of work underwater.

Does all this mean that after more than half a century of trying to get man-in-the-sea that there is now a rational, justifiable, mechanical stampede that will get man-out-of-the-sea? Some, amazed that anyone would seriously resist the new opportunities available through modern technology to gain unprecedented, safe, working access to three-quarters of the planet, half jokingly ask if the resistance to having man underwater is somehow related to a fundamental distaste for getting wet.

Whatever the causes of the controversy, the questions persist. Should the development of submersibles and the long and successful history of diving, living, and working underwater now be abandoned? Are we to concentrate only on the trend begun by *Challenger* scientists in the 1880s who explored the ocean by lowering their mechanical substitutes for human presence—dredges, nets, and bottles—to remotely sense and sample the deep sea below? Will the remarkable capabilities of our creations so dazzle and blind us that we belittle the significance of our own human intellect, judgment, and presence?

Oceanographer Dr. Roger Revelle once observed that one reason that machines would never totally replace men subsea is that "it is difficult to surprise a machine." Human beings act on continuously updated information, including unexpected breakdowns of equipment, unpredictable changes in routine, and the many unknowns of an unexplored area and reactions to unpredicatable behavior of creatures being observed.

Graham Hawkes, designer of the Wasp, Mantis and other deep diving systems pointed out a recent meeting of NACOA that building costs and day rates for ADS systems are comparable, sometimes less than for a large ROV. Further, he noted that by placing a man in an underwater system, approximately 60 % of the control system of an ROV designed to replace a man could be eliminated, thus reducing cost and complexity, and increasing reliability.

In sum, it seems puzzling that otherwise rational human beings should square off, toe-to-toe, and argue with an either-or, tunnel-vision approach to the issue of man in or out of the sea. A carpenter doesn't throw away his hammer when he discovers the wonderful properties of a wrench. A pianist is not likely to assume that he has coaxed every possible melody from a piano when he turns his attention to the flute. People have not stopped piloting aircraft although rockets and remotely guided missles now exist, and while satellites gather extraordinarily valuable data from the heavens above, plans are still being developed for men and women to live and work and dream in space.

ROVs no doubt will increase in number and kind and probably will dominate in the realm of well-defined work, repetitive tasks, for broadbased surveys, and for work in hazardous situations. Complementing this capability there surely will be the human presence, sometimes guiding the systems from deck chairs, sometimes as free-swimming or saturated divers, sometimes contained within atmospheric diving suits or submersibles—analogous to humans and machines working together as they do everywhere else, on the land and in the air.

It is not remarkable that an effective spectrum of machinery is at last being taken into the sea. What *is* remarkable is that some imagine that mankind will be content to be left sitting on the shore.

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

OCTOBER, 1983

Vol. XVI, No. 3, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to deep submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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San Diego, CA 92107
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EDITORIAL NOTES & COMMENTS

Welcome on board to David J. Hudacek, O-in-C DSRV-1 (MYSTIC), and also Randy L. Griffin, Engineer Officer of MYSTIC.

Ex-TRIESTE sailors be sure to read the ½FATHOM news item herein regarding the TRIESTE commemorative ring.

The National Technical Meeting of the Institute of Navigation will be held in San Diego, CA, 24-26 January 1984. The areas of interest for the sessions will be Satellite Navigation, Marine Navigation, and Aerospace Navigation.

On 30 August, I attended the OCEANS '83 MTS Conference at San Francisco. The session on Manned Subs and Habitats was chaired by Roger Cook of Harbor Branch. I enjoyed seeing many old friends and former associates, some of whom were or are DSPA members, including Bill Pinebrook, George Shaeffer, Bill Rainnie, Frank Busby, Brad Mooney, Carl Moeller, Frank Simpson, Deam Given, Albie Beutler, and Roger cook. Bill Pinebrook, former DEEP QUEST co-pilot, is now a PhD marketing his services in the areas of coastal and offshore engineering and operations. His Houston phone number is (713) 663-7547.--Frank Busby gave a paper on "Undersea Vehicles, 1970-1983, New Directions/SolidAchievements". His historic survey of the forces at work, the vehicle systems developed, and the people involved led him the the conclusion that we did pretty well even if we didn't get the government funding needed to keep our vehicles operational and to

utilize their full potential.--Dale Anderson of the West Indies Laboratoryspoke on "Hydrolab, A Valuable Tool for Marine Research", describing their sixteen or so 7-day saturated missions per year, living in the habitat at 50' with excursions to 100'. The Western Regional Ocean Lab to become operational under U.S.C. at Catalina in 1985 was also described. Of Perry design, it will house six aquanauts for 12 to 16, 6-10 day missions per year at 60'-100' with excursions to 200'.--Rick Wilson of Makai Research Pier on Oahu described the Research Submersible Makali'i(ex-STAR II), operated with the support of NOAA's Office of U/S Research. Since ABS certification in 1981, she has made some 170 dives at depths to 1200', including operations at Eniwetok and Johnson Island as well as off Oahu.--Graham Hawkes, Deep Ocean Engineering, told all about "A New Microsubmersible for Deep Water Work and Exploration". His JIM, WASP, MANTIS, and ARMS III work done in England has led him to his new company in Oakland, California, where he is building "DEEP ROVER". The initial one-man sub has a "clamshell" (mo hatch) acrylic personnel sphere designed for a 1000 m. working depth. The vehicle is to be modular design, simple, rugged, reliable, safe, and relatively cheap. Ultimately, it will have a 5" thick, ceramic-glass hull capable of diving to 37000 feet. DEEP ROVER will mount two Hawkes Sensory Manipulators incorporating sensory feedback of force, motion, sight, sound, and touch.--Inlight of the proven success of Graham Hawkes' previous vehicle designs, DEEP ROVER should be a project of great interest.

The DSPA monthly San Diego luncheon on 15 Seprember had an excellent attendance of about 24, including your editor and a pair of other WW II sub skippers as my guests. I almost am afraid to tell you that we were there because we were attending the celebration of the 45th anniversary of our graduation from the U. S. Naval Academy. The luncheon speaker was DSPA member Tom Vetter who detailed the DSRV-2 AVALON's "fly-away" from NAS North Island (San Diego) to Scotland to perform a practice rescue of personnel from a bottomed RN sub, HMS OPOSSUM.. HMS REVENGE served as the "mother" sub for the operation, transporting AVALON to the scene "piggy-back"for submerged launch and recovery. The "disabled" sub was readily located, mating performed , and AVALON personnel lunched on board on the bottom. All in all, 67 passengers were transferred between the two RN subs during five AVALON matings with OPOSSUM..

NEWS FROM MEMBERS

Bill Goldsby--Oceaneering International (July '83)
"I am now with ARMS Bell I. We are on the drill ship GLOMAR ATLANTIC and presently drilling off the Santa Barbara coast. I believe on my last update to the DSPA I was working with the SCORPIO 17 off the Ivory Coast Africa. It is kind of pleasant working in the States, no customs, language problems or long flights. However, drill support can at times be rather dull. But at least I am back on a manned vehicle."

Will Forman--(21 July '83)
"There were 18 in attendance at the July DSPA luncheon including Larry Shumaker and his daughter, Arthur Bancroft who Jack Bennett

fished out of the drink in WW II, and our special guest, John Howland. Bancroft was one of the Australians who worked on the bridge on the River Kwai. His prison ship was torpedoed, and Bennett's sub picked him and others up.--John Howland spoke for a brief bug highly informative period on the international agreements on DSRV's. The U.S.A., France, Canada, and the U.K. will have mother subs. Japan is building copies of the U.S. DSRV's, but no agreements yet for rescues of each other's subs.--I have Jerry Stachiw as speader for next month's meeting on 18 August. His subject will be plastic viewports on subs.--I sent the DSPA membership applications to the Japanese since my responses were overwhelmingly in favorof it."

Doug Privitt--MARFAB (22 July '83)
"NEKTON DELTA has successfully completed over 40 dives, test and contract , to date. The contract dives have been for G. O. CUBIC a new enterprise in Ventura, California, of DSPA members Jim Vernon and Rich Slater who have left McClellan Engineering to engage in this geophysical research and exploration venture. DELTA is an upgraded version of the NEKTON ALPHA, BETA, and GAMMA owned by NEKTON, Inc. Test depth is 1700 feet, operating depth1100 feet. My problems with ABS continue, They haven't responded to my last several letters."

Kevin Parker--SUBSEA OFFSHORE, Ltd. (28 August '83)
"I have just received the July Newsletter. No, my inkwell has not run dry. I have written to you and Will Forman and Tom Vetter during the last two years, but I have not had an acknowledgment. I sent some ---- and a request for T-shirts and stickers last year,-this envelope came back about January of this year, returned by the U.S. mail. I wrote again with twice the subscriptions and another request for T-shirts with a note on the BALDER CABOT / PELERIN bell rescue earlier this year. Please, will someone send me my membership cards, stickers, etc.-- I left H.M.B. Subwork in March; and, having heard so much about SCORPIO, I decided to join a company which operates them. So in April I joined Sub Sea Offshore, Ltd. I was initially Operations Controller on the Sedco 707 with SCORPIO 18. Now I have been given the SCORPIO 10 on the Benvrackie to play with. After eight years in the game I feel I am qualified to judge a vehicle. SCORPIO's are excellent. SSO uses them in many roles, survey,NDT, and -- support. The vehicles are uncomplicated and very reliable. As you may know, SSO is a large company and has its own R&D department. Field gained experience and reports have enabled SSO to build a new generation of vehicle called PIONEER, which is, according to the people who have worked on it, magic. It has all the power necessary to enable it to work in very strong currents, mainly due to its 3x120° thrusters and 50 H.P. main hydraulic motor.--Reading your Gleanings From Subnotes, I was very pleased to read John Westwood's article, The Return of the Kamikaze. His final paragraph sums up the market accurately, and it is this approach which will see large organized companies reviewing their recruiting criteria, raising operational standards , and so stay in the market. The old maxim "pay peanuts and you get monkeys " is true. Salaries and conditions over here now reflect the thoughts that if you offer good salaries, offshore rates, and good equipment, your personell department ends up having a choice

of several people for each vacancy. It should be realised that oil companies look for results and the cost, to a certain extent, doesn't really matter."

Will Forman--(18 August '83)
"The usual quick report on the San Diego DSPA luncheon meeting for August. Due in part to a Navy fly-away which began today, the Navy attendance was zero. There was a total attendance of 15, including four non-members. The speaker was Jerry Stachiw, and he was great. As you may recall , he was the man to develop NEMO at N.C.E.L. and is the authority behind ABS specs on viewports. He also has a textbook out on acrylics. He is, in many people's opinion, and I claim charter membership in the group, the world's leading expert on the structural use of acrylics. He showed, with slides and comments, the development of viewports, from one to many, and from hemi head bows to multi large frontal viewports. Various all-plastic (spherical) omni-directional viewing submersibles were next shown and described. These included his 12-piece NEMO, my 4-piece KUMUKAHI, and other 12-piece and 2-piece subs. Next, he described the transition and development from 1000' depths for NEMO to 3000' for the Johnson SEA-LINK and the ongoing efforts to go to 6000' in next-generation acrylic subs. He stated thet under present design methods this (6000') is the limit for acrylic hulls due to the stress and fatigue caused by the hatch metal-to-plastic interface. The interface problem limits cycling to 500 at 6000', decreasing proportionately at greater depths. He thinks it is time for glass again if someone with enough money does it right.--He was great; we all enjoyed it. Next meeting is on 15 September, as requested."

Larry Megow--Hahn & Clay (9 August '83)
"I don't remember if we have featured the DEEP ROVER subs before. However, the attached 7 August Houston Chronicle article, "Wave of the Future", is interesting and informative.--Incidentally, in Dallas, Texas, there is a new, large, high-class executive business center called "Las Colanas" in which all the buildings and hotels are connected by canals, similar to Venice. The mode of transportation is speed boats. Just think, in the future when traffic gets heavy, they can easily double-deck the water freeways, using submersibles."
(16 August '83) "Back in February 1983, in the January issue of Kawasaki Topics, Kawasaki released the news that Kawasaki was building a DSRV. The Japanese specifications parallel those of the two U.S. DSRV boats. Now the June 1983 Kawasaki Topics (copy attached) shows the deep ocean simulstor, built by them, that was used to hydro test the tri-sphere pressure hull for their DSRV."
(30 September '83) "I received the attached letter as a hand scribbled note. Sure would appreciate having any of your readers provide me with authentic information so that I can intelligently reply to Mr. Tibbit's interesting letter.

(see next page)

"Dear Sir:

I want to seat 8 people, also with beds in it. Please let me know how many feet down it can go. I want the cruising to go to 20,000 feet. Do you have anything that goes any deeper than that? Will they have a bathroom on it? If they don't go any deeper, how deep do they go? If so then send me the address. Please send me all the things about it. Please send me all of the literature and price list. Including the tax. And pictures that show all of the inside including the motor (in 4 cylinder and 6 cylinder sizes).

Arron M. Tibbit
1507 Mississippi St.
Monroe, LA 71202 "

(Ed Note: Any Member want to tackle this???)

Simple Data Retrieval Unit For Underwater Instrumentation

Engineers at Sandia National Laboratories, Albuquerque, New Mexico have developed a simple and inexpensive on-board acquisition system that eliminates the need for radio frequency telemetry in experiments with recoverable test units.

A number of applications are anticipated, including underwater instrumentation and high-altitude balloons.

The system provides a simpler and less expensive method for data retrieval than real-time telemetry, which required on-board radio transmitters and ground receiving stations. It stores data in its memory and then reads the data out when interrogated upon recovery. The system requires no ground support during operation of a test and only limited support (a device with a commonly available RS-232 serial interface) for data readout after the test.

According to Sandia engineers David E. Ryerson and Gene C. Hauser, who developed it, the system is applicable to any test on recoverable units where data acquisition speeds of up to 4,000 samples per second are needed. It is also useful in applications where a radio telemetry system is not feasible, such as underwater uses.

It will soon be used in the second of a series of tests of the instrumented seafloor penetrator, a Sandia-developed system for obtaining data about marine sediments. For this test series, two different units will be used, with one unit storing, processing and transmitting data from the seafloor via explosive acoustic telemetry and the second unit receiving and storing these data on the surface.

"It is basically a little computer that stores data which can be read out after the unit is recovered," says Ryerson. "It is simple, inexpensive, and reliable."

The stored data acquisition system consists of a microprocessor-based electronics package that digitizes and stores up to eight channels of analog data in a semiconductor memory. When the test unit is recovered, data can be read out via a serial data link to a printer for immediate data evaluation or to a computer for further data reduction. It uses low-power circuits that can be operated from a small internal battery pack for periods of hours to days. The unit consumes 1 watt of power and can operate from a supply of 13 to 35 volts.

Hauser explained that the system is completely software-controllable. It can be easily adapted to the user's needs for a particular test with no hardware changes. Transducers can be affixed directly to the system's module or wired in from an external location. Programmed data-gathering sequences can be initiated in response to an onboard clock, sensors, or pull switches. For instance, the sampling rate and sample-channel mode can be switched when a certain acceleration is sensed. The entire system, including the built-in D-sized battery pack, is 25 cm long, 12 cm wide and 9.5 cm high. With the eight-cell battery pack, the system weighs 3.8 kg.

Oceaneering ROV Operators See With Fiber Optic 'Eyes'

An advanced fiber optic umbilical cable system has been developed by Oceaneering International, Inc.'s Advanced Technology Group. The Houston, Texas firm has installed the system on its newest remotely operated vehicle (ROV), the 1525 m rated *ARMS Scorpio 5000*.

The fiber optic umbilical, which Oceaneering says is now operational, can carry all video, command and data signal transmission requirements for the ROV. Backup is provided by conventional coaxial cables.

Use of fiber optic conductors expands communications with the ROV, but they occupy far less space than equivalent coax cables. Other benefits include freedom from electrical noise radiated by power conductors in the umbilical and the ability to carry signals over longer distances without degradation.

The *ARMS Scorpio 5000* system includes optical-to-electrical converters mounted on the surface vehicle lifting winch and on the ROV's tether management cage (TMC), fiber optic conductors in the umbilical and ambient-to-one-atmosphere optical signal penetrators on the TMC.

Oceaneering said the penetrators have been successfully pressure-tested to 20,000 psig, equivalent to a depth of almost 14,000 m of seawater. Monitoring during pressure tests showed no degradation of signals at any test pressure.

SubNotes® by Deam Given

INTERNATIONAL NEWS ABOUT THE UNDERSEA WORLD

ROVs AID SUBMARINE RESCUE

A series of trials carried out by Sub Sea Surveys Limited for the Ministry of Defence (Navy) has established the feasibility of using a commercial ROV to assist in the rescue of a sunken submarine.

A SSS SCORPI was successfully used to locate a Royal Navy submarine positioned on the seabed off the coast of Scotland. The vehicle then used its television cameras to carry out an inspection of the submarine's hull. Using its manipulator, the SCORPI was able to deliver rescue equipment to the submarine, including 'posting' of life support containers through the submarine's escape hatch to the crew inside using a specially constructed handling system on the ROV. In the final phase of the trial the ROV was used to observe a dummy 'escape' from the submarine.

The SCORPIO was tracked from its support vessel by use of a 'Super Short Baseline' underwater tracking system, the results being fed into a Sub Sea Surveys computer system, which uses in-house designed software to produce a real time graphic display showing the positions of the Royal Navy's submarine, the ROV support vessel and the SCORPIO. Sub Sea Surveys Managing Director **Roger Chapman**, himself an ex-Royal Navy Submarine Officer, said, "We were very pleased with the outcome of the trials showing the capability of a suitably modified ROV to assist in a submarine rescue operation."

At present the rescue of trapped personnel from a naval submarine in shallow water uses the well proven individual 'free ascent' from the vessel's escape hatch. For deep water, such systems as the U.S. Navy's Deep Submarine Rescue Vehicle (DSRV) or the commercial British Oceanics diver lock-out submersibles must be used. However, there still remains the consideration of maintaining life support while the rescue vehicle arrives on site, which at the worst case may be up to 3½ days.

Using inputs from surface and underwater positioning systems, Sub Sea Surveys integrated navigation system, (normally used for the North Sea oil companies underwater survey work) generates a real time graphics display on a VDU and in hard copy format as shown. During the MOD (N) trials this was used on line to show precise positions of the Royal Navy submarine, the ROV and its support vessel.

IMPROVED SUBSEA VIEWING SYSTEM

Hydro Products, in association with Phillips Petroleum, has combined several innovations in monochromatic television systems which will substantially improve subsea viewing. The result is a new Computerized Camera with Integrated Measurement System (CCIMS) that will aid offshore operators who must inspect deep-sea structures, pipelines and wellheads.

The newest innovation is a smart range finding system that automatically focuses on a viewed object. A sonar beam is reflected off the object to an in-camera microprocessor, which determines exact distance. This and other data are relayed back to the surface control and video monitor, which superimposes a "scaling grid" over the transmitted image to show the exact distance and dimensions of the object even as its distance changes. With this system, Topside operators can accurately determine the true dimensions of such features as flaws in subsea members – judgments that in the past have been hard to make, especially in turbid waters where other visual cues are lacking.

A 2nd feature is a silicon chip array of tiny, photosensitive light cells, used in place of traditional TV tubes, thus enhancing contrast. Each light sensitive cell is a separate receptor, breaking up the incoming image into individual packets of light that are electronically reconstructed into a meaningful image. This Charge-Coupled Device (CCD) Array helps to control the blooming experienced in the traditional vacuum tube cameras when a strong reflection tends to flood across the screen and induce a general "white-out." Since light typically cannot spill over the boundaries of the CCD cells, such glare is localized to only those cells that are directly affected. To constantly control the light level response, an analog circuit automatically adjusts the size of the lens aperture. The video amplifier for the CCD, combined with the auto iris, has a large (approximately 650,000 to 1) dynamic range, producing excellent picture quality from low light to brightly illuminated scenes.

The 3rd feature of the system is improved sensitivity to poorly illuminated scenes. The CCD array is cooled thermoelectrically (as low as -40°F) thus reducing thermal noise and allowing the camera to make finer distinctions in the darker tones, where thermal noise would ordinarily present problems.

THE OFFSHORE TECHNOLOGY CONFERENCE

WELCOMES YOUR PARTICIPATION IN 1984

Although the 1984 Offshore Technology Conference will not include an exhibition, the meeting once again will serve as the world's most important forum for offshore technical information. Organizers are planning a 3-day meeting with formal presentations covering an even broader spectrum of offshore technology. Special sessions will highlight current projects and specific operating areas. The meeting format also will provide many opportunities for engineers, managers and industry experts from around the world to exchange ideas informally.

Four-man work submersible

Bruker Meerestechnik GmbH is building a new generation work submersible. The vehicle, of the Seahorse type, will have a rated working water depth of 200 m and a displacement of 50 tons. According to Bruker, the vehicle can operate for up to 7 days independent of the support ship. Delivery is set in 1984.

AT THE CONN

THOUGHTS RE AUTONOMOUS REMOTELY CONTROLLED SUBMERSIBLE (ARCS)

by **James R. McFarlane**

Over the last 20 years, there has been a revolution in the ocean. The evolution of diving systems, manned submersibles and ROVs is well known. Another facet of the work subsystem, autonomous remotely controlled submersibles, is now slowly beginning to evolve. As has been the case with other work systems, one can expect that the pace of development will become rapid once it is demonstrated that a cost benefit exists or that the task to be accomplished can not be undertaken in any other way. Additionally, ARCS will encompass a family of vehicles to satisfy a variety of perceived needs.

Torpedoes are a form of ARCS. Early versions ran straight lines at a defined depth; sometimes. Later versions incorporated active or passive modes and some decision making capability. In the last decade, pioneering work has been undertaken at ECA in France, NOSC in San Diego, University of Washington, University of New Hampshire, NOAA and ISE to produce work vehicles.

The tasks which ARCS will be used to address initially will be those which can not be conveniently undertaken by other means. These include under ice and deep ocean exploration. Once ARCS has established creditibility as instrument platforms in these areas, they will find uses in the oil patch where other devices such as ROVs, manned submersibles or divers are now employed. There will initially be a natural bias against their use because of our current preoccupation with real time information and justifiable concern that the job is being done.

Experience has shown that such bias is quickly, in historical terms, overcome, i.e., 3-4 years. The tasks which could be undertaken include:

- under ice bathymetry,
- nodule exploration,
- pipeline inspection,
- platform inspection,
- well head operations.

The ability to perform any task will depend on payload endurance, so called artificial intelligence level as well as data gathering and control sensors.

Additionally, system boundaries will in some cases encompass the job site to optimize results. For example, if a well head is configured with all the valves to one side and there is a work station of fixed geometry for the vehicle to key into, then it is clear that the use of a vehicle fitted with preprogrammed manipulators is feasible.

The configuration of ARCS will depend on the mission. For example, a vehicle which is a manipulator platform would generally be a high drag vehicle. However, a survey vehicle would generally be low drag to achieve long range at a modest turn of speed with conventional energy sources. Nuclear sources, such as the so called berylium reflected reactor could be used to power fairly large vehicles. An example might be the 50 foot long vehicle shown in th sketch. Such a vehicle fitted with a SEA MARC type sonar (side scan) could be used to map large areas of the ocean floor.

Typically the control system will be microprocessor based which is RS232 compatible. It can be expected that considerable effort will be expended on improving band width compression techniques both for control, verification of data, logging and image transmission.

The notions re the use of ARCS are immature and thus only a vague vision re their ultimate employment and configurations is perceivable.

MARKASUB of Switzerland has introduced its new E-3 manned sub. It's a compact 2-man sub for ops to 850 ft. and is based on the E1 (completed 1977) and E2 (completed 1980) designs. Life support is 20 man hours with 144 hours for reserve. Small size (10 ft. long × 6½ ft. wide × 7 ft. high) and good maneuverability enable the pilot to get close to most work sites. The prototype E-3 has been in operation for 2 years. Until April 1983, the sub had accomplished 152 dive days for a total of 230 dives. Max dive time was 5 hrs. 48 min. and the max depth was 705 ft. A 2-man E-4 is under development.

For details contact: MARKASUB, Gellertstrasse 53, Postfach 206, 4020 Basel, Switzerland. Tel: 061/423060; Tlx: 63 971.

OCEANEERING DEVELOPS ROV FIBER OPTIC SYSTEM

Development of an advanced fiber optic umbilical cable system has recently been completed by the Advanced Technology Group of Oceaneering International. The fiber optic system has been installed on Oceaneering's newest ROV, the 5,000-ft. rated ARMS Scorpio 5000, and is now fully operational. The fiber optic umbilical core has the capability to carry all video, command and data signal transmission requirements for the ROV. It is also backed up completely by conventional coaxial cables. The use of fiber optic conductors improves and expands communication to and from the vehicle while occupying far less space than equivalent coaxial cable. Other benefits include freedom from electrical noise (signal interference) radiated by the vehicle's power conductors within the umbilical and the ability to carry signals over much longer distances without degradation.

The ARMS Scorpio 5000 system includes optical-to-electrical converters mounted on the surface vehicle lifting winch and on the ROV's tether management cage (TMC), fiber optic conductors in the umbilical and ambient-to-one-atmosphere optical penetrators installed on the TMC.

Two crucial elements in the system, the umbilical cable and the signal penetrators, were developed along parallel paths. The umbilical was developed in conjunction with a cable manufacturer and includes 6 graded-index optical fibers as well as conventional coaxial cable (for backup) and electrical power conductors. Both load and cyclic tests have been conducted on the completed umbilical cable, confirming that all design parameters have been met.

The signal penetrators were developed by Oceaneering's Advanced Technology Group. They were successfully tested to a pressure of 20,000 psig, equivalent to a depth of almost 45,000 feet of seawater. Monitoring of the optical signals during pressure testing showed no degradation of the signals at any test pressure. The optical penetrator features a metal housing with multiple replaceable fiber penetrations, thus permitting replacement of individual fiber optic conductors. Patents on its design have been applied for.

OSPREY SUPPLIES CHINA

Osprey Electonics has completed an order for China for the design, manufacture and supply of an underwater TV system for a manned sub. Worth over £50,000, it follows 2 visits to Beijing at the invitation of the Chinese. The TV will be installed in a sub which will be used to support underwater inspection for the Chinese offshore oil program. The order includes a SIT resolution camera, depth transducer, video tape recorder, pan and tilt unit, ancillary lighting and control units.

Three Chinese engineers are in Aberdeen for 2 weeks training with Osprey in the use of the equipment and will return to China with the equipment in mid-august.

Developing the manned sub

The manned submersible still provides a versatile answer to a number of problems By Ian Dempster*

The multi-crewed manned submersible (MCMS) is still arguably the most versatile and cost effective underwater vehicle available in today's market. It may not dominate all aspects of that market but given an exacting and varied scope of works with the emphasis on accuracy and quality of result the MCMS cannot be bettered. And this is well proven by the continued use of British Oceanics Ltd submersibles by Shell UK Exploration and Production on the Brent, Cormorant, Dunlin and Fulmar fields and more recently by BP on the Magnus Project.

An exacting and varied scope of work could be defined as: pipeline and flowline inspection, concrete and steel structural inspection, pre-route and post-lay pipeline survey, seabed bathymetry survey, wellhead inspection, debris location and clearance with other one-off requirements, for example, the location and recovery of a helicopter which had crashed in 350 metres of water.

The submersibles are fitted as standard with 70mm stereo-photogrammetric cameras (with mono back up), three tube colour video, bathymetry suite and cathodic protection probe. In addition, a wide range of optional equipment can be fitted to carry out specialised tasks, such as: cross scanning profiler for pipeline or seabed inspection, pipe tracker, continuous monitoring, current density system, side scan sonar, sub bottom profiler, penetrometer, ultrasonic thickness probe and other hydraulically or electrically operated tools.

The versatility of the submersible is demonstrated in its ability to rapidly change roles, even in the course of a dive. Its autonomy enables safe and productive working in and around subsea structures. In fact the manned submersible has proved to be an ideal vehicle for category 2 and 3 platform inspection. It enables qualified personnel, in the form of the client's engineer, to examine directly and in three dimensions all areas of interest. The facility to change depth and position without reference to the support vessel, combined with the high manoeuvrability of the submersible, (10hp main propulsion, two 5hp tiltable side thrusters, two 5hp lateral thrusters, plus a dual ballast system) permits access to the innermost confines of the platform.

Clearly the quantity and quality of the data which can be assimilated by an observer at the work site is substantially greater than that obtained by a remote system which relays a two dimensional image to the surface. In addition the vehicle provides a very stable camera platform capable of producing top quality colour video and photogrammetric colour still photographs.

It is normally a requirement during structural, pipeline and seabed surveys that the geographic or relative position of the vehicle is known and recorded. This can be achieved by a super short baseline submersible navigation system integrated with the support vessel's surface navigation, (repeatable accuracies to 5 metres are the norm) or alterantively, with a long baseline seabed transponder system which can be tied-in to the 'real world' or can also be used for relative positioning, (repeatable accuracies down to 1 metre are achievable). When using the long baseline system the submersible is able to navigate within a transponder array using the onboard ranging/positioning system. The pilot is relayed a visual plot as to his position relative to a programmed track, as in the case of a pipeline/flowline pre-route survey.

In the case of a structural inspection the submersible pilot carries in the vehicle a three dimensional scale model of the structure with a pre-mapped route — a duplicate model is held in the control room of the support vessel.

This summary of the ability of the manned submersible to collect a comprehensive range of high resolution data at a known point beneath the sea is certainly not the end of the story. Possibly the most important part of any survey is the compilation of the final report and this is without doubt achieved most effectively offshore when the information is fresh in the minds of those who planned and executed the tasks.

This reporting system was developed on the British Voyager manned submersible spread for the 1982 and now 1983 seasons and should be considered a part of the development of manned submersibles as it is based upon the provision of a service that fulfills a market requirement.

Final reports are produced within five days of the submersible completing a dive task by a team of surveyors, video and photographic technicians, computer programmers, cartographers and reporting personnel. In the case of a pipeline survey, the reports include stereo photographs, detailed drawings, surveyors' reports, cross profiles and computer generated abstracts giving finite details as to areas of interest relative to time, position, kilometre post (KP) number, and with direct reference to still photographs and colour video.

British Oceanics also operate a range of equipment for one atmosphere transfer in both wet and dry environments. This system not only allows accessing of subsea working habitats but enables BOL to provide The Royal Navy with a rescue service for evacuation from a military submarine in distress.

Multi-crewed submersibles are by no means confined to purely oil related inspection works and personnel rescue but are used for deep drilling support, (commercial vehicles are available with depth ratings in excess of 6000 ft), torpedo recovery, minerals survey, oceanographic research, wellhead demolition, coral gathering, salvage, laying shaped explosive charges for seabed clearance, cable burial, one atmosphere intervention and countless other tasks.

The manned submersible is in a state of re-emergence and although it will never again achieve the successes of the middle 1970s, it still has a secure future with planned and applied developments.

The industry suffered particularly badly between 1977 and 1982 and the major operators of the time have all either folded or withdrawn from the market. The reasons cited are numerous and include: an intensely competitive market heavily oversubscribed in the mid 1970s, (in 1976 there were up to 12 available spreads), rapidly changing technology, and the change from the construction orientated phase of the mid 1970s to the predominantly maintenance orientated phase of the late 1970s and early 1980s.

Even so, rather than reasons for failure these are simply characteristics of the marketplace, and not unique to this particular market.

It could be argued that the lesson to be learnt from past mistakes is the need for both planning and adaptability. Certainly the vehicles themselves have not noticeably improved since the advent of glass reinforced plastic pressure hulls and the benefits they brought, and so todays MCMSs successes can be attributed to the appreciation of that lesson.

The problems of keeping ahead of the market are always present and there are several concepts which could improve the service in the near future, some more practical than others:

Combined spread: The idea of operating a manned submersible and a remotely operated vehicle (ROV) from one vessel is not new, it has been debated for several years and was put into practice during 1982, with reasonable success. Like all projects it requires planning and a reasonable margin for trials. Given that, and a DP vessel of the correct deck configuration the operational benefits would be:

☐ The ROV is ideal for major trunkline survey where minimal damage is expected and extended dive times can be achieved.
☐ Both vehicles can be used to effect on in-field pipelines. The ROV for general survey and the manned vehicle for close inspection of damaged areas, working in anchor patterns, under construction vessels and near platforms.

☐ The manned submersible to be used for platform inspection, debris search and recovery, high accuracy seabed measurements and site survey. (There will be many areas where either vehicle can carry out the same task).

This type of service could best be utilised on one of the large fields although it is sufficiently flexible to work on the spot market.

Umbilical power supply: British Oceanics is in the early development stages of an umbilical power supply for use with both observation and diver lock-out submersibles. Trials will be carried out during 1983 to improve and certify the concept with a view to commercial operation in 1984. The umbilical overcomes the manned submersible's principle limitation of battery power and, when applied to diver lock-out operations, this type of system could re-vitalise a service which was at one time a market leader but is now unable to compete with the modern DSV.

The benefits of diver lock-out are still the same:

☐ Greater mobility than any comparable system allowing a ready and safe access to the work site.
☐ Ability to lock out divers inside a structure, removing the need to extend umbilicals beyond safe working limits.
☐ Continuous visual monitoring by the diving supervisor ensures high levels of safety and efficiency.

The umbilical has two eject mechanisms which, coupled with an independent battery supply, remove the potential dangers caused by a DP vessel run off when working in structures or around anchor wires.

The principal drawbacks of diver lock-out are lack of power for diver heating and hydraulic tools, and the need to re-charge batteries after every dive. An independent power supply would remove these constraints enabling the system to be developed to a point where it could well compete in the NDT market when coupled with present submersible inspection capabilities.

Containerised system: Operators in the past have been burdened with a high capital expenditure for purchase, conversion, maintenance and day-to-day running costs for purpose built support vessels. An alternative to the dedicated support vessel is a completely independent containerised system which would give the flexibility to operate from a wider range of standard vessels such as the Ugland NVC-350 design. Modular configuration of component system parts would allow adaption to particular job requirements, be it a video platform inspection or a full blown pipeline survey.

Closed circuit diesel engine: Sub Sea Oil Services (SSOS) have developed a working closed circuit diesel engine which they have put through trials using their submersible, Leo. Advantages in observation and diver lock-out are similar to those of the umbilicalised power supply, although it could be argued that this system is superior because it maintains the submersible's autonomy and therefore its major advantage. It is understood that SSOS intends to build a new submersible to be operated from a DSV which they claim could double the diving capability of that vessel. The submersible is the GMS 16: dry displacement 18 tons, 52 kWh of electric power, 800 kWh of closed circuit diesel power, cruising speed 8 knots, three to four saturation divers.

Manned submersibles are here to stay.

GEAR PUMP WITH TEFLON GEARS

TUTHILL PUMP CO.—The Model 9012-T magnetically coupled gear pump has been announced. With a body of 316 stainless steel, it has precision helical gears of Teflon to provide utmost corrosion resistance and quiet operation. It has a capacity of 37 gph and can produce pressures to 60 psi. It handles fluids from −100 to 200°F and is safe for system pressures to 500 psi.

Subsea Manned Engineering. By Gerhard Haux. Best Pub. Co., Best Bookbinders, Publishing Div., 23005/2 S. Avalon Blvd., Carson, Calif. 90745. 1982. 528 pp. $42.00.

An authoritative survey of the design maintenance and construction of subsea equipment has long been required. This is just such a book, illustrated and edited by a consultant engineer of international reputation in this field.

The book presents a summary of recent developments worldwide and illustrates current techniques for engineers and designers. However, all who are involved in the planning and preparation of diving programs will find the detailed description of equipment and its uses of value. The text has a wide scope so that it can review in detail the important recent advances in the methods by which man (either under pressure or encapsulated, but directly controlling his movements) is able to work under water.

UK Dept. of Energy Releases Diving Safety Guidelines

The U.K. Department of Energy recently released the following diving safety memorandum:

The level of diving accidents and incidents in air diving operations from dynamically positioned (D.P.) vessels is giving cause for concern and, in particular, the potential hazard arising from divers or their umbilicals becoming fouled in propellers or thrusters.

Diving Safety Memorandum No. 21 of 1982 drew attention to these potential dangers. However, some companies, supervisors and divers do not appear to be following the advice provided.

Regulation 5(2)(a) of the Diving Operations at Work Regulations 1981 requires that every diving contractor, so far as is reasonably practical, ensure that each diving operation is carried out from a suitable and safe place.

Care must be taken in the selection of vessels and the personnel used for these operations to ensure that they have the necessary capabilities and are operated in a manner which meets the statutory requirements.

Proper procedures must be written into the diving rules emphasizing the importance of close and efficient supervision, good diver attendance and full communication coverage at all times. A vessel operating on D.P. may not always provide the necessary suitable and safe place for diving operations and other means must be considered. If a safe diving position cannot be maintained, then it should not take place.

The following list, which is not definitive, provides points for consideration when planning surface orientated diving from a vessel operating in the D.P. mode.

1. Need for good supervision.
2. Need for good diver tending.
3. Provision of efficient bridge/diving control communications.
4. Provision of efficient diving communications.
5. Use of an open bell or conventional bell.
6. Position of the diver close to the task.
7. Type of diving (i.e., splash zone area, shallow, deep, etc.)
8. Choice of diver umbilical (buoyant or heavy).
9. Use of cranes.
10. Use of anchors.

SUBMERSIBLE NEWS AND VIEWS

from IRENE FAGER

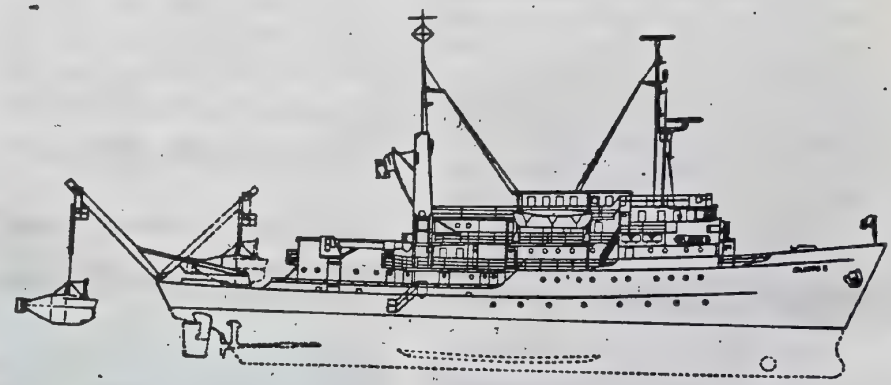
DSV Sea Cliff (DSV 4)

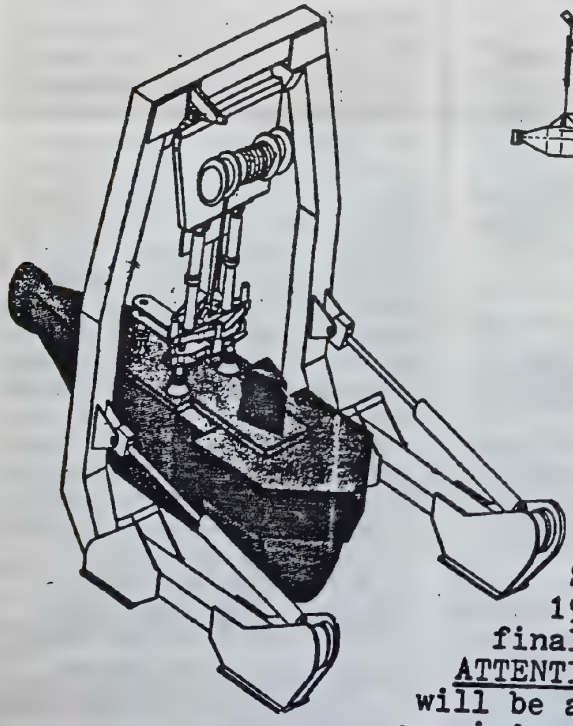
Sea Cliff is well into her RAV which upgrades her operational depth to 20,000 feet. The testing of the titanium sphere in Maryland completed Aug. 6 and the sphere was returned to Mare Island Aug. 10. Fabrication of the titanium frame is on schedule and will complete soon. All prefabrication is complete and final assembly is in progress. All production work is scheduled to complete by Oct. 11. System operational testing will complete Oct. 21 with *Sea Cliff* departing for sea trials shortly thereafter.

Mare Island 'Grapevine' August 12, 1983, p4

A letter from Ed Bland says they hope to start ALVIN/AII sea trials about mid-Oct., which sets the whole schedule back by about a month. Diving operations with LULU concluded with dive #1322, the last science dive. A limited number of covers were done (35) for dive #1322, with most going to the crew. However, Ed very generously got 8 which he will send for the auction. (Many thanks, Ed!)

The drawings below show the A II and the new A-frame installed to handle ALVIN.





The metal A-frame was constructed in Caley Hydraulics Ltd. in Glasgow, Scotland and shipped to the Boston shipyard for installation on A-II.. The schematic drawing at left shows the basic design of the system which uses hydraulics to raise and lower ALVIN from the ship to the ocean and back. The metal bases that will be attached to the A-II deck are pictured below. Photos by Jack Donnelly.

A nice letter from Daniel J. Kean, AOIC TRIESTE II, says that the bathyscaph will stay in active service for the remainder of 1983 and possibly as long as August 1984. They are planning to complete 4 dives during this time frame. Three were to start in September 1983 and the final dive in April 1984. A special stamp will be made for the final dive, now planned for April 1984.

ATTENTION FORMER TRIESTE CREWMEMBERS... There will be a special commemorative ring made and carried on the final dive and they would like all former crew members to have an opportunity to purchase one. So please contact them NOW. This ring is only for former TRIESTE personnel and not for we collectors. However, we can send our covers to...Officer In Charge, TRIESTE II (DSV-1), % FPO, San Francisco, CA 96679. Many thanks to AOIC Kean for his help and information.

Submarine NR-1 completed overhaul and departed the shipyard on August 22, 1983.

IUC COMPLETES AT SEA GOVERNMENT DEMONSTRATION
OF WORLD'S DEEPEST UNTETHERED ROV

International Underwater Contractors Inc. (IUC), has recently completed a series of deep water bottom photographic surveys for various government agencies to demonstrate the capabilities of the "Epaulard" in water depths of 1200 to 3800 meters with IUC's Support Vessel "ALOHA" offshore California and Oregon.

The "Epaulard" is the world's deepest untethered, unmanned ROV which is acoustically controlled and capable of diving to 6000 meters. Its capabilities also include taking up to 5000 35mm photos per eight hour dive and can be outfitted with different scientific instruments for completing various tasks, i.e., lost object search, modular field exploration, nuclear waste dumps survey, etc.

The "Epaulard", built by ECA, owned by CNEXO and operated by IUC in North America is a field proven system with over 120 dives to its credit.

Additions to the "Epaulard" in the near future will include:

-- Vertical bow thruster

-- Acoustic real-time television transmission

The contract was directed from IUC's newly formed California office IUC PACIFIC at Santa Barbara.

Specifications:

General

Operating depth:	20,000 feet (6,000 meters)
Length o.a.:	13 feet (4 meters)
Height:	6.5 feet (2 meters)
Width:	3.6 feet (1.1 meters)
Weight:	2.9 tons (6,400 pounds)
Speed:	3.2 feet/second (1 meter/second) with 1-speed reverse and temporary overdrive
Descent speed:	2.7 feet/second (.8 meters/second)
Ascent speed:	2.7 feet/second (.8 meters/second)
Autonomy:	6 hours on seabed
Range:	11 nautical miles
Power:	1 pressure-balanced 48-volt lead-acid battery
Propulsion:	Oil-pressure balanced electric DC motor. Downward and upward propulsion provided by drop weights secured and/or released by electromagnet
Payload:	Extra load capacity of 88 pounds
Buoyancy:	± 70 daN

Work & Documentation

Camera:	■ Benthos 377 35-mm camera with 3,000 and 5,000 exposure magazine, taking black and white photographs every 5 or 10 seconds. Photographs bear the data: depth, altitude, course and hour. When taken from 21 feet (7 meters) photographs cover 320 square foot area.
Strobe:	■ 220 joules
Magnetic recorder:	■ Includes cartridges. DC100 cycles 5 seconds, two extra channels available when depth, altitude, course and hour recorded
Compartment:	■ Removable pressure resistant titanium compartment for camera magnetic recorder and control and data-processing electronics.

The DSRV-2 is the first sub to conduct simulated rescue operations under greater than one atmosphere internal working pressure. They also transferred personnel from a submarine resting on the ocean floor to another submarine. The HMS OPOSSUM acted as a disabled submarine and the HMS REVENGE was their "Mother sub". Dive #430 demonstrated their ability to transfer supplies and personnel from one submerged submarine to another without surfacing, as all transfers were conducted.

"NEKTON has been involved in a long term biosurvey in the area of the West Santa Barbara Channel. Diving operations started in Jan. and continued in phase increments - in March and May. So far in 1983, we have made 56 dives, totaling over 100 hours of dive time. We will be operating again starting in mid-Sept., running possibly into Oct., in the same area. We have also recently (7-28-83) made 2 dives during recertification of submersible GAMMA by the ABS. One dive (#1305) was to a depth of 320' with Pete Traphagen pilot, and the other (#1306) was to a depth of 1010' with me piloting. The operation took place off San Pedro, CA and required a 1 day total operating time. Up to this time (8-8-83) NEKTON submersibles have logged 2,976 dives: ALPHA - 829; BETA - 842; and GAMMA - 1306.

I got a great letter from Al Witcombe, which I'll share with you, that tells all about the dive series. Many thanks, Al!

Quote: "Just a note to bring you up to date on PISCES IV activities. We're back in full swing again after four weeks stand-down for maintenance and vacation. We have just completed a most successful cruise - 8 dives out of a possible 10 - on Axial Seamount. The dives were made right into the volcanic crater, or caldera, as it is known. It's hard to describe the surface down there - the condition made by the hot magma, frozen by the water in the most bizarre and weird shapes possible. After a few survey dives we discovered a major vent field, where we established all our experimentsand took a great deal of photographs and video. The PISCES returned tube worms and other biota and also specimens of the rock structures including a meter long inactive chimney weighing about 160kg. It was interesting to note that as PISCES dislodged this blocked and inactive chimney from the sea bed it reopened the vent and water was seen to start flowing. The average dive time was 9 hrs per dive and this was made possible by an improvement to the ballast system enabling us to conserve power for bottom running. The descent time per dive was averaged at about 20-25 meters per minute, so the round trip took about 3 hours. "

SHIPS WITH WINGS TO SOAR UNDERSEA?

Cargo vessels of the future may glide through the water on wings, using a propulsion system that mimics the way some fish swim.

An unmanned, winged submarine glider, slightly longer than a football field and 56 feet wide, was recently designed at the University of Wisconsin, Madison. According to its architect, mechanical engineer Ali Seireg, a glider would be safer than the surface ships that now carry much of the world's transoceanic cargo. "Underwater, you don't have the problems encountered on the surface. Whatever happens—whether it's rough seas, waves or hurricanes—makes little difference to the glider." A convoy of these vessels, he adds, would be functionally equivalent to a pipeline and could be constantly monitored by satellites.

In designing the glider, Seireg considered the way certain fish move through the water. These fish have an organ called a swim bladder that enables them to regulate their depth. When they want to swim closer to the surface, special glands secrete gas into the bladder, making their body more buoyant. Later, when they want to go deeper, the gas is released and buoyancy reduced, allowing the fish to sink more easily.

Utilizing a fabricated gas bladder, Seireg built a small-scale submarine glider for use by scuba divers. The craft had only a five-foot wingspan, but it worked so well that Seireg decided to design a larger model. The proposed vessel, whose hull would be made of a durable fabric stretched over a frame, would alternately employ buoyancy and gravity as the driving force for forward propulsion. Like a fish, it would have a gas bladder, which would be attached to the hull, to create positive and negative buoyancy. For the glider to rise, a small explosive would go off, forming gas that would inflate the bladder. Later, at the peak of its climb, the gas would be automatically released, the bladder would telescope back to its original state, and the negative buoyancy would force the glider deeper. The hull and wing configuration would transform these vertical movements into forward thrust, and the vessel would be propelled through the water in a zigzag fashion.

The glider Seireg designed should be able to haul about 10,000 tons of crude oil, natural gas or other cargo, and travel at 10 miles per hour in a zone 100 to 1,000 feet beneath the ocean's surface. But the design of the glider and its depths of operation could be changed to meet the needs of potential users.

Seireg says that the cost of operating a glider would be less than that of operating ships or conventional submarines because the glider, having no engine, is very energy efficient. And a smaller system, he says, could have other applications—for example, it could be used to economically propel scuba divers, small submersibles or research instruments underwater. ■

Subsea rescue device

A subsea location and rescue device introduced by Aberdeen-based Bennico is aimed at overcoming some of the problems associated with underwater vehicle recovery.

Based on the principle of using a marker line to guide a stronger lifting line and triggered into action either by the submersible crew or — if the umbilical of an unmanned vehicle is severed — automatically, the device is attached to a vehicle prior to launch.

Designed in California by Hydroscan, it comprises a self-clamping hook with a metre of heavy cable, attached to more than 300m of Du Pont's lightweight Kevlar line within the case of a marker buoy. Should a problem occur, the luminous buoy is inflated by a gas bottle and rises to the surface taking the Kevlar line with it. On recovery of the buoy, a heavyweight sleeve with lifting cable attached is run down to the submersible. The end of the sleeve carries a self locking clamp which locks onto the short length of stronger cable so that lifting can begin.

Bennico also sees the device finding application as a subsea tagging and lifting system for many seabed recovery operations.

Bad Weather Foils Hunt for the Titanic

New York

Bad weather and heavy seas yesterday forced searchers to abandon their hunt for the sunken ocean liner Titanic in the North Atlantic, a spokesman said.

The spokesman, Michael Jahn, said the research ship Robert Conrad is heading back to Halifax, Nova Scotia. He said the storms were interfering with radio communications and he had no other details about the end of the search.

Jack Grimm, a millionaire oil man from Texas, financed the expedition. Bad weather also thwarted attempts by Grimm in 1980 and 1981 to find the luxury liner, which struck an iceberg and sank on April 15, 1912, taking 1513 lives. A fortune in jewels and other valuables is believed to have gone down with the ship.

The searchers had been looking for the spot where what was believed to be a propeller from the Titanic had been photographed on an earlier expedition.

12/83

Service Machine Group Develops Plans for a Diving Support Vessel

Service Machine Group, Inc., a Terramar company headquartered in Morgan City, La. in cooperation with Design Associates, Inc., of New Orleans, has developed plans to produce a 205-foot diving support vessel (the DSV 205).

Service Machine president **Tom Hensley** and **Mat Kawasaki** of Design Associates, naval architects and marine engineers, said the vessel carries a White Gill thruster system and Z-Peller main drive for computerized dynamic positioning. The vessel is designed to utilize heavy fuel for economy of power and maintenance.

Planned primarily as a specialized vessel for diving work in the Gulf of Mexico but with severe environmental capability, the 300-meter Lloyd's classed system permits saturation of 12 divers for continuous eight-man operations. The three-man bell fitted for observation or lock-out dives is to be equipped with internal and external television to receive input from computer depth scanners.

The bell also carries duplicated hardware communications self-contained through a water emergency telephone, a semiautomatic oxygen injection system, and divers' gas reclaim system.

The DSV 205 bell handling system includes a heave compensated winch, composite umbilical and winch, captive cage, guide wire system, bell control cabin overlooking moon pool, four point mooring, and a bell handling area.

Mr. **Hensley** said the chamber complex includes three 2,300-mm four-man living chambers with back projecting TVs for entertainment and briefing, hospital facilities, two vertical 2,000-mm transfer chambers with showers and toilets, three external gas regenerators and manifold, as well as a saturation control cabin.

Powering the DSV 205 are four main engines Wartsila Vasa 22HF model 8R2HF 8-cylinder, 1,000 kw capacity at 900 rpm (1,250 bhp) harbor generator 4R22HF with 500 kw at 900 rpm (625 hp). These engines provide 4,000 kw to supply the SCR system for the main drive and auxiliary power.

Measuring 205 by 50 by 22 feet, the DSV 205 accommodates 60 persons with fully air-conditioned living quarters with recreation rooms, lounges, offices, and a heliport.

Special equipment aboard the DSV 205 includes a 50-ton crane, a 25-ton crane, and a Gantry crane to handle diving bell entry and retrieval through the moon pool. Also, the vessel design includes an "A" frame on the stern for deployment and retrieval of RCVs and ROVs. Ample helium storage space is provided, and the vessel carries an anti-roll tank. Uses projected for the vessel include salvage, industrial development such as pipeline inspection, pipe repair, rig inspection, jacket installation, pile grouting, pipeline riser hookup, and pipeline trenching support, as well as geophysical and military assignments.

Harbor Branch Foundation Awards Atlantic Marine Research Vessel Contract

The Harbor Branch Foundation, Inc. of Fort Pierce, Fla., recently contracted for construction of a new 176-foot ocean-going research vessel. The announcement was made by managing director, **Dr. Robert S. Jones** on behalf of Harbor Branch president, **J. Seward Johnson, Jr.**

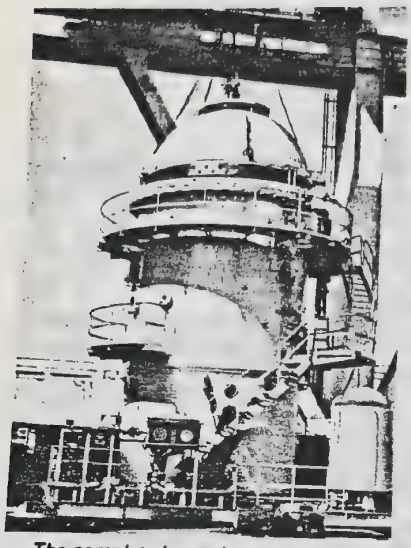
The contract was signed by director of marine operations, **Roger Cook** and **Ed Doherty,** president of Atlantic Marine, Inc. of Jacksonville, Fla. The ship was designed by Rodney Lay & Associates, Inc., also of Jacksonville.

The new research vessel, to be named the Seward Johnson, will replace the 125-foot R/V Johnson as the primary tender for the Johnson-Sea-Link submersible system: two 4-man submarines designed and built by Harbor Branch engineers.

The vessel will be a state-of-the-art ship designed specifically for oceanographic research, complete with workshops, laboratories, and the capability of transporting and launching both submersibles. The ship will be outfitted to support missions of 30 days or longer. It will carry 60,000 gallons of fuel, have a range of 8,000 nautical miles, and will be able to negotiate all the major oceans.

)))Ironclad *Monitor's* Anchor Recovered by Harbor Branch, NOAA, Off Cape Hatteras. The payoff in a mission hindered by capricious North Carolina Outer Banks weather and poor undersea visibility came at 9:52 a.m. EDT (1:52 p.m. GMT) August 29 as a lift bag bearing the 590 kg, four-pronged anchor of the Civil War Ironclad *Monitor* broke the water surface in calm weather some 16 miles southeast of Cape Hatteras, North Carolina. The recovered anchor has been transported to the Greenville, North Carolina campus of East Carolina University for preservation. Participants in the mission were Harbor Branch Foundation, Inc., Fort Pierce, Florida (who furnished technical expertise, the support ship *R/V Johnson* and diver lockout manned submersible *Johnson-Sea-Link I*); the National Oceanic and Atmospheric Administration (NOAA), who funded the major part of the $95,000 project; and representatives of East Carolina University's Program in Maritime History and Underwater Research. NOAA has jurisdiction over the *Monitor* site, which has been declared a national marine sanctuary. Questions not completely answered during this week-long project include the technical feasibility of raising the vessel's distinctive turret and of possibly raising the wreck piece by piece for subsequent reassembly on the surface.

Test vessel for deep ocean simulation



The complete-layered test vessel features the "finger pin closure" system.

KHI recently finished constructing a complete-layered test vessel of 4,500 mm inner diameter with a quick, full-opening closure, or so called "Finger Pin Closure," under a licensing agreement with HAHN & CLAY, Houston, Texas, U.S.A.

It is believed that this is the first complete-layered (built-up walls of thin metal layers) vessel and the largest test vessel for deep ocean simulation ever constructed in Japan.

The test vessel's finger-pin-closure system has a unique design that employs no bolts, threads, breech or clamp. The new closure system's capacity to withstand tremendous pressure and its efficiency in operation are accomplished by a combination of interlocking tapered "finger" and high-strength radial pins. This system also allows the operators to fully close or open the vessel in a matter of minutes.

Another technological innovation employed is the complete-layered construction of the vessel's sealed ends (heads) and cylindrical shell sections. In these parts, high-strength, high-quality as well as thin, quenched, and tempered steel plates are used, and they are arranged and welded in a manner to transform detrimental residual welding stresses into beneficial pre-stresses without any need for heat treatment after welding.

High-pressures require metal thicknesses that do not lend themselves to uniform heat treatment, and high physical properties are difficult to achieve at the midpoint of thick, single sections. In fact, large, thick, single-wall vessels present complex material, fabrication, post-weld heat treatment, and nondestructive testing problems that sometimes defy solution.

The complete-layered technology, however, gives the designer the freedom to optimize process designs and move to high-performance, large-diameter, heavy-wall vessels without compromising safety, and provides the perfect "building block design" especially effective in vessels subjected to hydrogen embrittlement.

In addition the complete-layered patented procedures permit high pressure vessels of unlimited size to be field fabricated and erected. ●

MMS to Prepare EIS for OCS Hard Mineral Resources

As announced in the *Federal Register*, the Minerals Management Service (MMS) of the Department of the Interior plans to prepare an Environmental Impact Statement (EIS) for the offering of hard mineral leases on the U.S. outer continental shelf. This OCS lease sale is scheduled for the second quarter of 1984.

The area under consideration is the Gorda Ridge in the Pacific Ocean, an active seafloor spreading center about 160 to 330 km west of Oregon and northern California. Mapping and survey work in this area, as reported previously in *ST*, has indicated that the area may be rich in metalliferous sulfide minerals, including copper, zinc, chromium, molybdenum, silver and platinum.

Eastport International Performs East Coast Cable Operations

The Ocean Search Division of Eastport International, Inc., Lanham, Maryland, recently completed undersea operations of the *SCARAB II* vehicle in cable laying and repair missions along the Eastern Seaboard continental shelf of the United States, logging over 500 hours of submerged operation of the unmanned, tethered vehicle.

Ocean Search's customer was the Atlantic Cable Maintenance Authority, whose major members consist of AT&T Teleglobe of Canada, British Telecom International, the French Post Office and the British firm Cable and Wireless PLC.

Operating from the Canadian Coast Guard dual purpose ice-breaker/cable ship *John Cabot*, *SCARAB II* surveyed, cleared, then buried to a depth of one meter, approximately 10 nm of transatlantic telephone cables in depths of waters ranging from 36 m to 900 m. The surveys and burials were conducted on two separate transatlantic cables, the TAT3 and USA/Bermuda cable systems, as part of an effort to minimize damage caused by fishing vessels in areas of high fault incidence.

The mission lasted from April 14 to June 23. During this period *SCARAB* worked 30 operating days, 24 hours/day, for a total dive time of 502 hours. This included one continuous 57 hour burial dive.

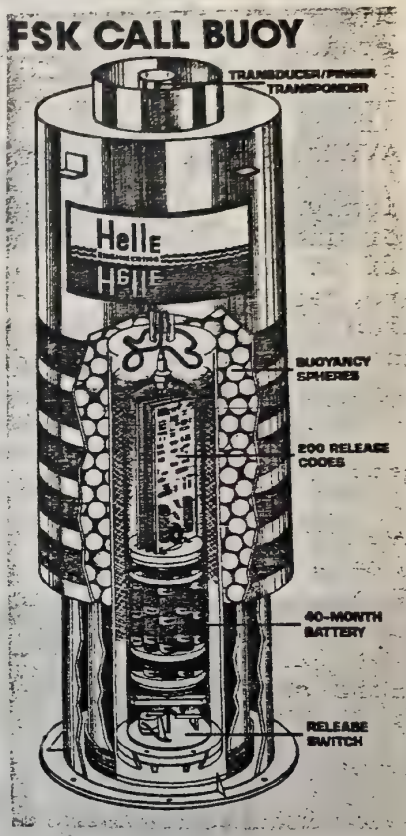
The clearing of the cables prior to burial involved cutting entangled fishing and trawl gear, removing various concrete blocks and an anchor, and utilizing the saw on one of *SCARAB's* manipulator arms to cut and remove a 1.8 m long piece of 10 cm dia. inactive telephone cable which crossed over the TAT3 system.

The planned operations were interrupted for an eight day period to allow the *John Cabot* to proceed to repair the TAT4 Transatlantic Cable which had been damaged by a clam digging vessel off the New Jersey Coast.

SCARAB surveyed the fault area prior to cable repairs and the decision was made to remove several previously repaired sections, splice in and re-lay four nm of new cable, and then bury it using SCARAB. This work was originally planned for 1984 but was deemed necessary under the existing circumstances.

NEW CALL BUOY SYSTEM FEATURES TWO HUNDRED ADDRESSES

Helle's new FSK Call Buoy System caught the eye of many visitors at the Offshore Technology Conference. They particularly were impressed by Frequency Shift Keying (FSK), a signal coding method that permits the topside unit to call any one of up to 200 buoys. Thus many Helle buoys can be deployed in close proximity without fear that the wrong one will be released. This innovative system has three main components.



When released, the basic Model 5240 FSK Call Buoy rises to the surface, unwinding 200 feet of a plastic-coated and impregnated steel cable. Four other models are available with cable lengths from 400 to 1,000 feet. The Call Buoy also serves as an acoustic transponder and beacon (pinger), acknowledges release, and is powered by a 40-month battery. The buoy measures 65 inches in height and 19 inches in diameter.

With the exception of the transducer, the Model 5235 Release Module contains the buoy's vital electronic, battery and release parts. The transducer is located within a protective cage on the top of the buoy and provides the pinger and transponder functions. The user can change the release channel of the buoy by sliding the electronics section out of the module and manually setting switches on a printed circuit board.

The topside Model 5230 FSK Interrogator features a state-of-the-art liquid crystal display. It uses two lines of 16 characters each to display such system data as battery life remaining in the buoy, buoy code, range of the buoy from the interrogator, buoy release and pinger operation. To ensure against accidental release of the buoy, four actions must be taken before the release command can be transmitted to the Release Module in the buoy.

High Tech: *Electronics search for Nessie*

In an attempt to capture the Loch Ness monster, an American expedition has turned to high-tech electronics to search for the fabled creature, which has been hunted for a half- century in the Scottish Highlands lake.

Rikki Razdan and Alan Kielar, both of Rochester, N.Y., switched on the underwater sonar probes on their electronics-packed raft earlier this week and waited with special harpoons at the ready for the monster to swim into range.

The harpoons the explorers hope to use on Nessie are harmless, employed to obtain samples of skin and tissue from wild land and sea animals.

Tony Harmsworth, curator of the Loch Ness Monster Exhibition, said anything big enough that swims within 100 feet of their 80-foot-square raft will be a target of the biopsy harpoon and should yield sufficent samples to identify the type of animal.

For 2½ months, the two Americans worked in Drumnadrochit, Scotland, to outfit their raft with 144 sonar devices and nine biopsy harpoons. Drumnadrochit has been the center of Nessie hunting for a half century in the lake 450 miles north of London.

Scores have claimed to have seen or photographed such a creature in the last 50 years, but no one has turned up conclusive evidence that it exists.

Omega Declared Operational in Additional Areas

On the basis of an extensive data collection and validation effort, the U.S. Coast Guard recently declared the Omega navigation system to be operational in the North Atlantic and North Pacific oceans.

It has been determined that Omega meets the safety of navigation accuracy requirements of 2–4 nautical miles with 95% confidence in the oceanic environment as stated in the U.S. Federal Radionavigation Plan (March 1982) in the two regions bounded by approximately 0–70 N latitude, 15E–100W longitude, and 10S–70N latitude and 100W–165E longitude.

For further information, contact:
Capt. I. C. Uithol, USCG
Chief, Radionavigation Division (G-NRN-2)
U.S. Coast Guard
Washington, D.C. 20593
Phone 202-426-0990.

Requirement for Complementary Navigation System Eliminated

The U.S. Coast Guard, Department of Transportation has eliminated the requirement for a complementary system to be used with satellite navigation receivers required on vessels of 1600 gross tons or more, and allows the carriage of a "stand alone" satellite navigation receiver to meet the requirements for an electronic position fixing device.

The Final Rule was published in the Federal Register, Vol. 47, No. 251, December 30, 1982. For further information, contact:
Mr. Tom Falvey
Office of Marine Environment and Systems (G-WWM)
U.S. Coast Guard Headquarters
2100 Second St., S.W.
Washington, D.C. 20593
Phone 202-426-4958.

Bubble Opens Up Submerged World

OAKLAND, Calif. (AP) — Someday, teen-agers may go cruising in sports subs 3,000 feet under the sea. Executives may take long lunches off the continental shelf.

An egg-shaped, underwater craft called Deep Rover is coming on the market, and its designers say it will open Earth's last frontier in ways dreamed about only by science fiction writers and the most imaginative oceanographers.

Invented by British engineer Graham Hawkes, Deep Rover is a relatively cheap, one-person acrylic bubble with robotic arms capable of construction work, prospecting or drawing detailed diagrams. It has a comfortable seat with a 360-degree view, and Hawkes says anyone can learn to drive it in half an hour.

The battery-powered sub uses thrusters and propellers to "fly" through the water more than half a mile below the surface — 1,000 feet deeper than any similar craft.

A second generation already has been designed for work at 7,000 feet in 1985 and a journey to the deepest part of the ocean — seven miles down — is planned with a later model in 1987.

Hawkes is president of Deep Ocean Technology Inc. of Oakland, a company he founded in 1981 with American scientist Sylvia Earle. He had left OSEL Group of England, which he helped build into a world leader in manned diver systems.

Hawkes and Ms. Earle share a sense of adventure and a passion for proving that the sea is more than just a highway for ships. They see a future of underwater restaurants and hotels, farms and seabed mines.

"The idea of living underwater is not a wild idea," Hawkes says. "Most of the big rigs in the North Sea have concrete structures in 500 feet of water. The stress and fatigue problems are actually less in building that type of structure than they are for a high-rise on land. So the way-out plans for restaurants and hotels under the water are not in the least bit wild."

In 1970, Ms. Earle led a team of five women who lived 50 feet below the surface for two weeks to show that humans could live and work comfortably in the water. She received an Interior Department Conservation Service Award.

"The idea of living underwater is not a wild idea."

Hawkes developed the Wasp, a bubble-headed, propeller-driven diving suit, and modified "Jim," the 800-pound Iron Man designed by English inventor Joseph Peress in the 1920s for a salvage operation.

In 1981, Hawkes piloted his mini-sub, Mantis, in the filming of "For Your Eyes Only" and whipped James Bond's larger submarine four times in outtakes before he let himself be beaten.

Hawkes says he designed the Deep Rover "to be a quantum leap rather than a gradual next step" in manned, deep sea workcraft. He believes the egg is the shape of the future and that changes will be refinements rather than fundamental shifts in design.

"If the Deep Rover is successful in the way we'd like it to be, 10 years in the future people will regard it as the 'Model T' of submersibles," he says. "It looks super-sophisticated, but in reality it's far more simple. This breaks some barriers."

The primary market for the Deep Rovers is the offshore oil industry, Ms. Earle says, "because that's where the demand exists and the money is."

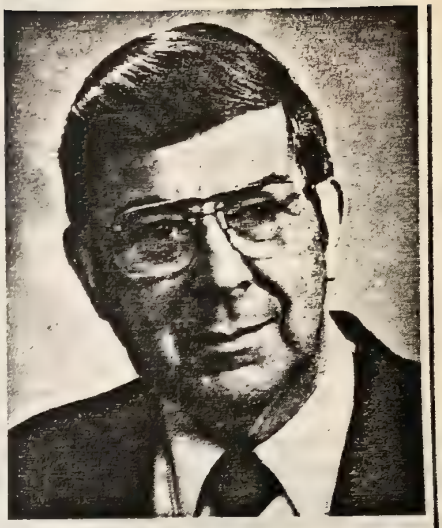
The first Deep Rovers will sell for about $600,000, but the price could be slashed to less than one-tenth of that if they're mass-produced. Over the next decade, she sees lower costs and a much wider market.

"Even little kids will be out scooting around in those things," she says. "Stuffy executives from behind desks who would never dream of putting a scuba tank on, you won't be able to keep them out of it."

Scuba divers currently are limited to 200 feet. Other one-person submersibles can't go lower than 2,000 feet and are far less maneuverable. The average depth of the Pacific is 13,739 feet and the average depth of the Atlantic is 12,257 feet.

Reduced Backlash For Synthetic Fiber Ropes

R.L. Stanton, President
American Manufacturing Company



R.L. Stanton

Those who design, manufacture, distribute and use fiber ropes containing man-made fibers such as nylon, polyester and polypropylene are well aware of their advantages and disadvantages. As compared to their predecessors (manila, sisal, jute and coir) these recent products of man's ingenuity are stronger, lighter, more durable, more elastic and more resistant to damage by water and chemicals.

Because of these and other advantages, the change from natural to man-made fiber ropes accelerated rapidly following World War II. The transition to larger, more powerful oceangoing vessels and tugboats by the marine industry made the lower weight and superior strength of synthetic ropes especially appealing. By the mid-60s, manila ropes virtually disappeared as mooring and towing lines. As the parade of new fibers marched into view, nylon, polyester, polyethylene and polypropylene each found its own special niche. And before long, blends of these fibers were developed to provide certain desirable properties which the individual fibers by themselves did not offer. Such a combination of fibers was developed by American Manufacturing Company to incorporate the more important features of several ropes into a unique, patented product called PNX. This was the first of the modern-era combination products and was introduced to the marine trade in 1958.

With the advent of stronger, more elastic ropes of man-made fibers, the dangers associated with all types of ropes, *when used improperly*, were increased. The age-old safety precautions to users of ropes of all kinds took on more urgent dimensions. Because these synthetic ropes stored much more energy under load than their predecessors, they possessed higher recoil/backlash tendencies and posed a greater threat of damage and injury to equipment and people. Thus, basic safety warnings (i.e., against (1) standing in the direct line of pull of any rope, (2) using a rope or end attachments that are too small or too weak or otherwise unsuitable for the job, (3) using a rope that shows signs of age, wear, abrasion, hockling, kinking, cut yarns or damage from heat, water or chemicals, or (4) overloading a rope or rope assembly) became even more critical than heretofore. Failure to observe these warnings and other well-known handling procedures have resulted in serious damage to equipment and injury to personnel when ropes, fittings or assemblies broke due to overloading.

Recognizing the need to reduce the recoil/backlash of synthetic ropes and still retain the desirable properties, American Manufacturing Company commenced work several years ago on rope designs which were intended to accomplish this objective. Several such novel rope constructions are now offered by American for mooring and towing applications. These include, but are not limited to: (1) six-strand "Circle Lay" ropes with a center core; (2) eight-strand "2 x 4" plaited ropes; and (3) nine-strand "Kno-Kink" cable laid ropes.

In each construction, the desired reduced backlash characteristic is provided for by utilizing the correct proportion of "high stretch" and "low stretch" components. Essential to the design principles involved in each construction are the following requirements.

A. "Low stretch" components must break before the "high stretch" components break.

B. The time interval between the breaks of the "low" and "high" stretch components must be sufficient to permit substantial relaxation of all "low stretch" components after breaking and prior to the breaking of the "high stretch" components.

C. The mass (or bulk) of "low stretch" components, after break and relaxation, must be great enough to control the mass of the "high stretch" components to the extent desired in limiting snapback of the rope.

D. The mass (or bulk) of "high stretch" components must be sufficient to maintain their integrity and resist the destructive effects of the breaking "low stretch" components. In other words, the "high stretch" components must remain intact until all the "low stretch" components have broken and relaxed sufficiently.

E. The position of the "low stretch" components must be specified in such a way that they will control and contain sufficiently the "high stretch" components when proper breaking sequence is achieved.

Although the three aforementioned ropes are designed to reduce the recoil/backlash tendencies of synthetic ropes, it should be clear to all that improper use of or damage to even these ropes can neutralize or negate their reduced backlash design features. A final word of caution — all ropes should be used with care, and normal safety precautions, including regular inspections, should be exercised at all times. All parties involved in selecting, purchasing, storing, inspecting, approving or handling ropes assume certain responsibilities and liabilities with respect to the proper condition, use and performance of those ropes. Abuse or misuse of these special ropes, which in any way interferes with the five design criteria outlined above, may reduce considerably or void completely the reduced backlash properties of the new ropes.

TV-Like Pictures at 100 Meters

British-Developed Scanning Sonar's First Use in American Waters was in Locating Sunken U.S. Warships in Lake Ontario

By D. Cattanach
Chief Development Engineer
UDI Group Ltd., Aberdeen
and
E. W. Cookson

Underwater inspection in offshore oil and gas installations in the North Sea is an important tool of the industry. In the recent past until the present there have been two major systems—conventional underwater photography with film and video cameras with either system operated by divers, or cameras taken to the site by robots. In either case, visibility ranges were of a low order, extending to about three meters.

Another approach was with commercial sonar, but was lacking in fine definition and required skilled photographic interpreters to gain useful information.

Now the UDI Group Ltd. has developed a scanning sonar whose definition is said to be akin to a TV picture rather than the usual sonar recording. (Figure 4) The AS360 can produce on a video screen a plan view of the seabed, or a section through the side of an underwater structure or wreck over an area about 200 meters in diameter. Recent developments show that the sonar has a variety of applications in oceanographic research.

With a video system more than one operator can follow underwater activities closely in real time, with each operator performing his individual task. In addition, permanent records can be taken directly from the video screen using a video graphic recorder.

The system design incorporates techniques such as linescan conversion and display storage which, until recently, were both cost-prohibitive and bulky, restricting the equipment to military markets. Now, the rapid advancement of integrated circuit technology has allowed the design engineers to incorporate these methods into compact packages.

The sonar head measures 34 by 20 cm and can be fitted to fairly inaccessible positions in underwater structures. Further, the size of the control monitor was chosen to allow access through a 48.24 cm (19 in.) diameter submarine hatch.

Weighing 2 kg in water, the AS360 scanning head can be operated with a conventional pan-and-tilt mechanism or deployed on a drill string, or over the side of a small boat. (Figure 3.) It can be carried on a remote-controlled submersible or diving bell, or fitted to a tripod or the deployment cage of a small Remotely Operated Vehicle(ROV). Pan and tilt allows both plan and profile views to be made during the same deployment.

Broad Applications

Three broad areas of oceanographic use have emerged during trials this year: topographical surveys, oceanographic measurements and underwater search.

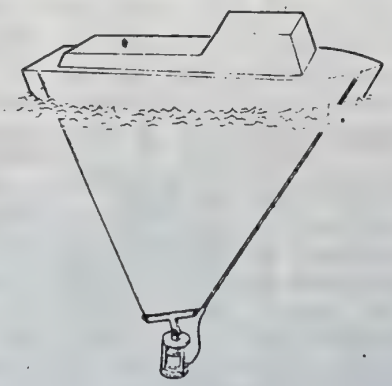


Figure 3.

The AS360 produces a 27° vertical by 1.4° horizontal beam width transmitted at 500 kHz. It can scan a 360° circle around the inspection area or various segments from 15° to 270°. (Figure 5) The resultant real-time TV-type picture, and video record, allows the underwater surveyor to detect not only large geological variations on the seabed, but minor depressions, sand waves and trenches. Relatively small objects, such as the tripod of oil drums (Figure 1), can be clearly seen.

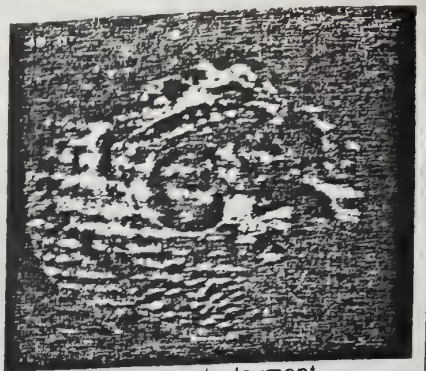


Figure 2, midwater deployment.

This 100 m scan was taken in Collykhan Bay, Scotland, which has high cliffs on two sides, the outline of which is shown to the top and bottom of the picture. To the right, there is a gradual incline to the beach.

For closer inspections, the oceanographer can vary the sonar range from 100 m to 40 m, 20 or 10 m. Figure 2 shows a 40 m scan through 360°, the AS360 being located at the center (blindspot) of the resultant picture. Small scattered objects, possibly pebbles, are shown with only one target of any significance at between 10 and 12 o'clock and 20 m from the scanning head. The dark areas indicate seabed indentations.

In the profile mode, scanning sonar can be used for surveys of sea defenses or offshore platforms. The sonar is mounted so that it can scan vertically to detect damage or scouring around harbor walls or piles.

It can display a section of the side of the wall some 50 m diameter—an area impossible to match by conventional TV inspections. Expensive diving time can be limited to closer inspections of specific areas of the structure. Similarly, the AS360 can produce not only a plan view of an area crossed by a pipeline, but also a profile of the pipeline in its trench. (Figure 6).

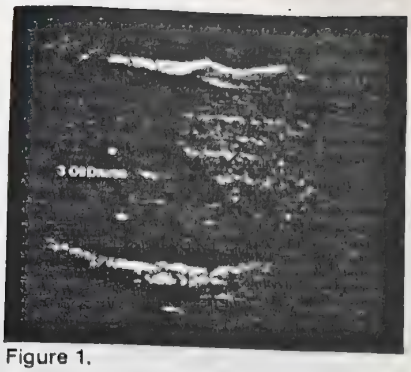


Figure 1.

Pipeline Trench Inspection

The resolution of the AS360 (to a few centimeters) shows whether a pipe is fully covered or not, the state of the trench and any suspensions. The scanning head is mounted horizontally, allowing scans to be made across the trench while the ROV tracks along the trench. A complete profile of the scan is completed in approximately five seconds.

It can also be used to determine the trench geometry. The depth of a trench relative to the mean seabed level often cannot be fully appreciated from the limited area covered by a TV inspection, because of the level of overspill on each side of a trench.

The system, which can be switched from profile to plan in the same deployment, allows the true depth of the trench to be calculated by giving a visual comparison (in the same view) of the trench depth to the mean seabed level.

Figure 4.

Similarly, in the profile mode, it can be used to monitor the movements of silts in confined areas. Scanning sonar has recently been used by one oil company to measure the build-up of scour around offshore platforms. In Figure 7 , the AS360 is suspended 3 m from the seabed. Between the four platform legs, cross members and bracings can be clearly seen. Three risers are shown to the right.

The AS360 has been used during surveys in the Eastern Scheldt region of Holland, a tidal area about eight kilometers wide with sandbanks and channels up to 35 m deep.

Originally the estuary was to be entirely closed by means of a dam to protect the low-lying hinterland from flooding. Later it was decided to build a storm surge barrier in order to conserve the unique ecology of the area. (Figure 8) In normal circumstances, the barrier will let in and out approximately 70% of the previous volume of water and will be closed entirely during storms.

Basically, the plan is that the islands and dikes have been constructed on the sandbanks by pumping up material from the bed of the estuary. In the three resulting channels, together 3200 m wide, the bottom is to be filled in with fine sand and covered with prefabricated filter mats on which a total of 66 piers were due to be placed during 1982. A stone sill, concrete beams and movable steel gates are to be built between each of the prestressed piers.

The height of the concrete structures will be about 50 m. The AS360 was used to inspect underwater cementing, grouting and the laying of the large foundation mattresses in waters of zero visibility-for which TV was impractical.

When completed in 1985, the build-up of sands around the barriers can be inspected by scanning sonar over a period of time.

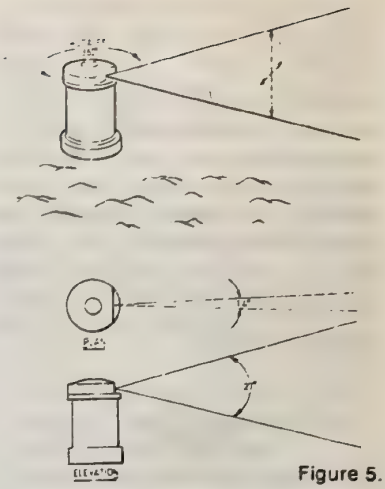


Figure 5.

Oceanographic Measurements

The AS360 is currently undergoing trials as an inspection tool during oceanographic studies where the target is slow moving and may cover or travel across a large area. The movements of marine organisms and natural phenomena, such as sand patterns, provide two such examples.

UDI has been involved in the study of iceberg movements off Canada. The AS360 can be used to map out iceberg 'coastlines' and how they vary over time, and also to measure the depth of ice beneath the surface.

Underwater Searches

The AS360's image-forming capabilities are such that not only large underwater structures, such as wrecks and oil platforms, but vehicles, small packages and divers can be easily recognized. It can be used in search applications to support and guide a diver during TV inspections close to the target (for it is unlikely that the resolution of TV over short ranges will ever be surpassed) or as an inspection device in its own right over large areas.

Surface crews can update the video picture from the AS360 every few

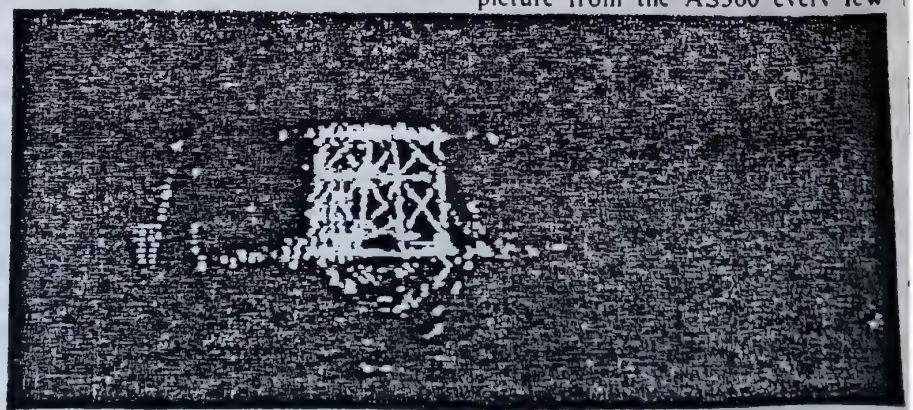


Figure 7.

seconds such that the movement of submersibles and small objects can be clearly detected. They can easily track a diver using the AS360 fixed to an over-the-side mounting or from a bell and, via an underwater communications link, can direct him towards his targets or away from obstacles. In Figure 9 a picture was taken during an inspection of the gate seats, or scallops, on the Thames Barrier in London. The diver, in waters of zero visibility was guided to an unidentified object.

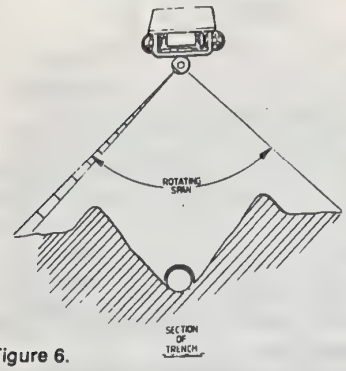


Figure 6.

Diving supervisors can save valuable time in the location of a workplace that requres saturation diving or during rescue operations by scanning a large area in one sweep.

The AS360 was used for the first time in American waters this spring by a team from *National Geographic* magazine to guide a Benthos RPV-430 submersible around the site of two American warships, the *Scourge* and the *Hamilton,* sunk in Lake Ontario in 1813.

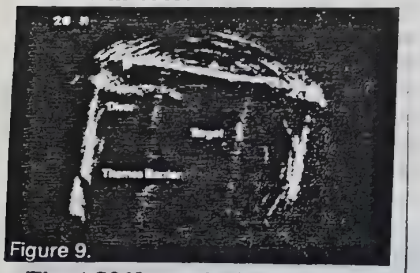


Figure 9.

The AS360 was deployed from the RPV cage to locate the wreck (92 m down and 8 km from shore) prior to a closer inspection with TV cameras.

The ships were found upright, listing slightly, and almost intact except for spars and blocks that had fallen as the sails and rigging gave way.

A 100 m scan was taken in October 1982 in Bergen Harbor, Norway of known wrecks lost at moorings during peacetime.

The search possibilities of the AS360 are not restricted merely to large targets, such as wrecks. Scanning sonar can be used to search for expensive tooling lost over the side of oil platforms, underwater packages, buoys and measuring instruments such as current meters.

Debris inspection over an area 70 m radius from a platform is now mandatory in the North Sea. The AS360 was approved by the British Department of Energy in April 1982 as an acceptable alternative to a diver's debris search of such areas and has been used extensively on debris clearance surveys during the recent North Sea season.

UDI engineers stress that the versatility of the new system is such that many oceanographic and marine navigation applications have probably not yet been considered. There are few underwater tasks in which an extra long-range 'pair of underwater eyes' cannot be used. The 100 m range at high resolution makes the AS360 a most important advance in underwater inspection. ◙

The Scripps Logbook

Oceanographers from the United States and Mexico are combining research interests in large-scale studies of the forces that drive the water in the Gulf of California, Mexico.

Scientists at the Center for Coastal Studies at UCSD's Scripps Institution of Oceanography are joining with their colleagues at the Center of Scientific Research and Higher Education (CICESE) of Ensenada, Baja California, in the three-year program. The association allows for joint research program planning and the sharing of equipment and ship operations.

"Both groups of researchers, working together on similar areas of interest, can benefit greatly from each other's resources and experience," said Dr. Saul Alvarez-Borreo, CICESE director. "Through this cooperation, better research plans and experimental models can be devised that will be very fruitful for both institutions in their efforts to measure and define the physical parameters of the gulf, an area of extreme importance to the economy of northern Mexico."

The joint research program reflects a new thrust in Scripps's physical oceanography studies, intensive monitoring of areas termed "marginal seas."

Marginal seas are semienclosed seas widely open to and connected with the oceans at the water surface, but bounded at depth by submarine ridges. Since they are mostly surrounded by land, marginal seas are active sites of fishing, shipping and other commerce.

The structure of the Gulf of California, a narrow, long body of seawater with open circulation to the Pacific Ocean and two shelves separated by a deeper section, makes it ideal for marginal sea studies, according to Dr. Clinton D. Winant, an associate professor at Scripps Institution and one of the principal investigators in the gulf research. It is typical of several other marginal seas such as the Adriatic, the Gulf of Thailand, and the Yellow Sea.

Winant said another reason for studying the Gulf of California is that the research interests of the Scripps scientists will complement experimental programs by Mexican scientists. An array of tide gauges has been deployed around the gulf by Mexican oceanographers and they are planning to equip the ferryboats that cross the gulf with expendable temperature recorders. The U.S. scientists began their field work last April, taking a 20-day cruise on the El *Puma* to place instruments in the Gulf. Winant expects the Scripps team to return to the Gulf in November, and twice a year thereafter.

The ocean processes of the gulf to be studied include measurements of water density, temperature,and currents. A myriad of instruments are used to record these parameters during cruises on U.S. and Mexican research vessels, from temporary installations, and with data transmitted from floating buoys. Understanding of these processes will aid in studies of ecology, pollution dispersal, navigation and marine fisheries.

The Scripps researchers participating in the program, in addition to Winant, are Dr. Robert T. Guza, Prof. Myrl C. Hendershott and Dr. Nancy A. Bray. Mexican researchers are Drs. Antoine Badan-Dangon and Niels Christianson of CICESE and Dr. Nicholas Grijalva of the Universidad Nacional Autonoma de Mexico, and Secretaria de la Marina. ■

Umbilical power test scheduled this year

BRITISH OCEANICS LTD. (BOL) plans to conduct tests during 1983 on an umbilical power supply designed for use with both observation and diver lock-out submersibles. The goal is to certify the concept and have a commercial system in operation in 1984.

The umbilical will be designed to overcome the manned submersible's principle limitation: i.e., battery power. When applied to diver lock-out operations, this type of system will compete aggressively with alternate diving systems.

During late 1982, the company completed a 180-day contract in the North Sea for Shell consisting of pipeline inspection, concrete and steel structural inspections, pre and post-lay surveys, debris location and clearance, and an emergency salvage operation at a 350-m depth.

During this contract, BOL's manned submersibles *LR2* and *LR3* worked with the support vessel *British Voyager*. The submersibles come equipped with stereo cameras, color photogrammetric cameras, 37 mm mono camera and color video to provide a detailed record of work on the dive. The video work is complemented by commentary by the pilot, and the customer's representative can be taken aboard for on-site observation.

Optional equipment that can be used includes side-scan sonar for debris recovery, cross-profiling system for pipeline or seabed inspection, continuous monitoring current density system, and hydraulically operated tools.

New Type Submersible Can Be Used In Manned Or Unmanned Mode

Britain-based HMB Subwork Ltd. has developed the Mantis-ROV, said to be the world's first submersible capable of operating in either the manned or unmanned mode. The unit's first contract will be to work for Petro-Canada offshore Newfoundland in the Atlantic Ocean.

The unit will be deployed from the diving support vessel *Balder Cabot*. The vehicle will work in partnership with the first generation Mantis, a one-atmosphere manned submersible with which HMB Subwork works in the worldwide manned drilling support market.

HMB says the manned/unmanned submersible will be a solution for oil companies which have to use both the unmanned vehicle yet have a manned unit on hand where only human skills can be used on specific projects.

The Mantis-ROV will carry out most routine tasks with no pilot aboard, controlled as a robot by its pilot on the support vessel. When there is no substitute for the human eye and on-the-spot judgment, the Mantis-ROV will carry its pilot under normal atmospheric pressure to the worksite, avoiding the high cost of conventional saturation diving.

S.S.O.S Launches First Diver Lockout Minisub With Incorporated Closed Cycle Diesel Engine

The Italian underwater engineering firm S.S.O.S., based in Milan, has launched the world's first diver lockout minisub to incorporate a 90 HP closed cycle diesel engine. Launch took place at the firm's new base in Gaeta where final sea trials took place.

The Phoenix 1350 is designed for offshore civil and naval operations at maximum depth of 350 m. Its maximum working time on the seabed is 20 hours, which is a breakthrough in comparison with current limits. The longer operating period will also improve the chance of rescuing personnel trapped when a submarine is immobilized on the seabed, S.S.O.S. believes.

The minisub with powerful manipulators is essentially a multipurpose vehicle for transportation of saturation divers to their work location down to a maximum depth 351 m, its underwater range is 250 nautical miles and maximum speed is 9 knots below the surface (6 knots on the surface).

The pressurized lockout chamber can accommodate four diver technicians, whose working functions are facilitated by the accurate positioning capability afforded by the very powerful thrusters on the outside of the submarine.

As the problem of cold affecting saturation divers at such depths is solved by the unlimited heat source from the engine itself, there is no need for any support vessel on the surface to supply heat via an umbilical or for any other purpose.

The incorporated closed cycle diesel engine has no external atmospheric intake/discharge, since after purification the exhaust gases are recycled to the engine intake itself, with variable input of oxygen as required.

Further data on the Phoenix 1350 are as follows: overall length 11.4 m; width 3.0 m; height 3.0 m; weight 25 tons; collapse depth 701m; life support system for 192 man/hours in operation and 576 man/hrs in an emergency.

Plastic hull for Italian sub

The closed-cycle diesel engine submersible produced by Italian Sub Sea Oil Services has been fitted with a composite fibre/epoxy hull which has saved 500kg in weight, according to Du Pont which supplied the material.

The outer hull is constructed of Kevlar, a high-strength aramid fibre instead of the fibre glass originally specified. The pressurised inner hull, currently made of steel will be constructed from carbon fibre and Kevlar, in future models according to Du Pont. Weight could also be saved by making breathing gas bottles out of the same material.

SUBTECH '83 — an international conference

SUBTECH '83, an international conference on the design and operation of underwater vehicles, is to be held in London on 15 to 17 November 1983. Papers to be presented at the conference will emphasise present technology and future trends, and will cover:

vehicles — special purpose vehicles
manned vehicles
remotely operated vehicles
operational requirements
design trends

equipment — underwater visual systems
oceanographic instruments
navigation and position-fixing
vehicle tools
training and design aids.

One of the main objectives of the conference is to enable designers, operators and manufacturers to meet and exchange ideas. In addition to the formal conference sessions, a number of informal discussion groups and workshops will be organised to provoke discussion on important issues.

The conference is being organised by the Society for Underwater Technology and will be held at the London Tara Hotel. It is intended that there will be a display of models of underwater vehicles and equipment in the conference reception area. Anyone wishing to take exhibition space should contact the Society for further details.

Further information: The Society for Underwater Technology, 1 Birdcage Walk, London SW1H 9JJ. Tel: 01-222 8658.

Advanced systems for underwater vehicles.

Published by the Society for Underwater Technology, 1 Birdcage Walk, London SW1H 9JJ.

Softcover. 110pp. Price £27.50 members (£39.00 non-members).

The increasing use and complexity of the tasks demanded of underwater vehicles, both manned and unmanned, has resulted in the need for more and more sophisticated vehicles and equipment. This document contains the proceedings of a one-day seminar held in February 1982 to discuss new concepts and developments aimed at improving vehicle efficiency.

The 10 papers cover all aspects of vehicle development and use including a multi-sensor navigation system, design of the pilot/vehicle interface, recent advances in manipulators, ndt systems, underwater cameras and modular transmission systems, and image processing techniques to improve the resolution of photographs taken underwater.

IUC Canada Offers *Pisces VI* Submersible Services

IUC Canada, with offices in Halifax, Calgary and Montreal, is offering for lease the *Pisces VI*, the deepest-diving Canadian built manned submersible, with design depth of 2,530 m. The sub, working in the waters offshore Newfoundland, has supported deepwater drilling to the depth of 1,486 m.

IUC Canada works in conjunction with Canamount Construction, Inc., a company with experience in marine construction, installation, repair and engineering.

In addition to the *Pisces VI*, IUC Canada has two Mantis one-man, one-atmosphere tethered submersibles, including the new model that can operate as a remotely-operated vehicle (ROV) and reportedly has 300% increased thrust. In addition, diving services from shallow-water through saturation capabilities are offered, as well as the services of ROVs.

For further information, contact IUC Canada in Halifax at (Main office) Halifax Insurance Building, 5670 Spring Garden Rd., Halifax, N.S., Canada B3J 3J1, tel. (902) 429-8110; in Montreal at 2045 Stanley Street, Suite 1500, Montreal, Quebec, Canada H3A 2V4; tel. (514) 842-2581; or in Calgary at 900 One Palliser Square, 125 Ninth Avenue, S.E., Calgary, Alberta, Canada T2G 0P6, tel. (403) 263-1680.

I.S.T. Acoustic Telemetry Data Link Tests Successful

International Submarine Technology, Ltd. (I.S.T.) Redmond, Washington has successfully tested an acoustic telemetry system that they claim provides a reliable 50 baud, full duplex, synchronous link through water. Communication was maintained at a disance of four miles and at speeds up to seven knots despite external noise and severe multipath interference in the local test site. Even better results are expected in its planned operating environment under arctic ice.

This Acoustic Telemetry System was designed to be used in a free swimming ROV being built by International Submarine Engineering, Ltd. of Port Moody, British Columbia, Canada for bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada.

West Germany

Small submersibles for carrying out various underwater tasks have been designed by Ingenieurkontor Lübeck and built by Maschinenbau Gabler. These midget submarines are equipped with grab arms with a reach of 1.90m to carry out six different functions.

The Tours (tourist observation and underwater research submersibles) series consists of 12 different submersibles, of which two have so far found application in the offshore industry. These are the 64 DGK/300 and the 66 DGK/300, each with a maximum diving depth of 300m.

A Tours 64 was delivered to Taiwan and a Tours 66 to Sardinia for seabed analysis work. Not only were these units equipped with a hydraulic grab arm, but also with a swivelling underwater searchlight and a collecting bucket.

In addition to the trim tank there is provision for further trimming via a hydraulically or manually driven trim weight to equalise changes in the load distribution when the collecting bucket receives additional loads.

Both the 64 and 66 versions are manned by two people, a navigator and an operator. The Tours 66 is 7.30m long and weighs 14.5t as against the 64's 6.90m and 14t. Both have 50kWh stored in the main battery which gives them a cruising range of 21 nautical miles at a speed of 3 knots.

The designers consider that the Tours 64 and 66, with underwater endurance and manoeuvring capabilities, are particularly suited to tasks on the continental shelves, including pipeline route surveying, diving and rescue missions, surveillance and inspection, and oceanographic research.

ANNOUNCEMENT AND CALL FOR PAPERS

Marine Technology Society - Hawaii Section

PACIFIC CONGRESS ON MARINE TECHNOLOGY

April 24-27, 1984
Princess Kaiulani Hotel
Honolulu, Hawaii

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OBJECTIVE

The role of marine technology in the economic development of the Pacific Basin resources has engaged the serious attention of planners, policymakers, administrators as well as educators and scholars. This Conference is designed to bring together scholars and resource persons who will address key issues concerning the marine technology related to the ocean economic potential of the region from a multi-disciplinary perspective. The meeting will facilitate an exchange of views and ideas between representatives of the Pacific Island nations and of the larger rim countries and thereby strengthen future information exchange and collaborative research linkages.

Cut along dotted line

Please place in an envelope and mail to: PACON 84, Center for Engineering Research, University of Hawaii, Honolulu, Hawaii 96822.

PACIFIC CONGRESS ON MARINE TECHNOLOGY

April 24-27, 1984 Honolulu, Hawaii USA

REGISTRATION FORM

Complete the following information (type or print) and send with a check for $160 (US) prior to March 15, 1984, or $180 (US) thereafter, payable to MARINE TECHNOLOGY SOCIETY, PACON 84, to cover registration, luncheons, reception, banquet and the Proceedings.

☐ Check if you plan to stay at the Princess Kaiulani Hotel.

☐ Check if interested in Exhibitor Information.

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DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

JANUARY, 1984

Vol. XVII, No. 1, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to deep submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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President, DSPA
1527 Linwood St., Apt. #5
(619) 295-0620

Timothy P. Caffarella
Membership Chairman, DSPA
5079 Brighton Ave.
(619) 224-0143

EDITORIAL NOTES & COMMENTS

Welcome on board to the first Japanese Pilot Members: Katsumi Sakakura and Masahiko Ida. Both are employed by JAMSTEC as pilots of SHINKAI 2000.

The Marine Technology Society Journal, Third Quarter1983, was a special issue entirely devoted to "atmospheric diving systems". Actually, it is centered almost completely around Graham Hawkes' JIM, WASP, MANTIS, and DEEP ROVER. There is so much of interest that I did not extract any of it for this NEWSLETTER. I would rather encourage Members to find a copy and read the whole issue. Any Member so desiring may borrow my copy.

"Logistic Support of A Manned Underwater Production Complex" by Michael E. Jones is available from Graham & Trotman Ltd at a pretty steep price. Any Member who has access to a copy is urged to send me a review thereof, especially of the chapter on submarine support vehicles.

"Ocean Optics VII" is the title of a symposium cosponsored by SPIE-the International Society for Optical Engineering- and the U.S. Naval Postgraduate Schoool convenes at Monterey, California, 25-28 June, 1984.

Ye Editor's Lament. Isolated as I am from the real world of operating submersibles here in Northern California, more than ever I

require the assistance of all Members to make this Newsletter worth the cost and effort of publication. Send me letters, clippings, anything you consider worthy of passing along to the other Members. We do not solicit paid advertising but will gladly accept usable copy from your company at a price little more than that of that of handling. You will note that I use advertising clippings of general interest as fillers at times also. Members' personal information ads will be accepted at any time without charge.

NEWS FROM MEMBERS

Kevin Parker--SUBSEA OFFSHORE (12 November '83)
"I am still with Subsea Offshore. I started with them in March of this year as a day rate Operations Controller. I then was offered a salary in the same position and them two months ago I was promoted to the position of Senior Operations Controller. I am still attached to SCORPIO TEN and I have been mainly employed on drill support work. After so long doing mainly this, I suppose it does tend to get a bit repetiticus; but then there is always the odd incident to brighten the day. I have been working on three rigs, the SEDCO 707, the BENVRACKIE, and the KINGSWORTH U.K., all in the English sector of the North Sea. Recent government measures seem to have revived the need for exploration drilling , and so there has been an increase in drill support activities. The fleet of ROV's operated by S.S.O is always expanding, and I am ashamed to admit I am not sure that the figure is 34 or 35 just now.--I have not been out on a PIONEER yet, although I can't wait to get my hands on one. People who I work with do not seem to understand the reason for the tears in my eyes when I see a whopping great 50 hp-motor sat in the middle of the same sized space frame as a 25 hp-driven SCORPIO. I suppose it would take an old PISCES hand (two 5 hp thrusters)to really appreciate the reason for my satisfaction. From what I have also seen and heard of the vehicle, it is a strange beast in that it enjoys a considerable amount of operatorinput both in the design stage and the construction and the projected way of operating it. I have also been told that the first three models have different manipulator packs on them: rate, position feedback, and forced feedback. That is on top of the extensive add-on packages of survey equipment that can be utilised, should the contract call for it, with which S.S.O. has been so successful in the past.--The manned market over here seems to be as depressed as ever. There are just four vehicles working now, two of which are dedicated to M.S.V. type work,a figure which is a long way from the halcyon days of 1973-1978, when, I believe, there were upwards of 30. I have not, of course, included in this figure the various patterns of A.D.S. systems, MANTIS in particular,which are used extensively in the North Sea, Even though they are being used, I can forsee a reduction in their utilisation in the manned role role as more pressure is brought on the market to remove man from the sea completely. Fortunately, those MANTIS operated by HMB have an option of being operated in an ROV mode and also enjoy a considerable wealth of talent in the years of offshore experience which their operatirs have, I know of at leasttwelve of their personnel with more than seven years in commercial vehicles.--Also, of course, S.S.O. has this characteristic

running through the C.V.'s of their operators, as is to be expected with such a proliferation of ex-Vickers people on their books.--One of my old colleagues is over in San Diego, I believe, Colin Williams, who is Base Manager, or equivalent, for HMB or the company with which they are in joint venture, if indeed they have a partner over there. Try to get hold of Colin; he has years of experience in the game, and I am sure he will entertain you in depth at one of your meetings if you can get in touch with him.--That's all for now. Please try to find out what happened to all the subs I sent overand the requests for T-shirts and stickers.--Merry Christmas to you and yours and,of course to all the Members over there (and in Japan?)."
(Ed's Note: above items to Will Forman and Nihil Smith for action)

Jerry Shiller--NEKTON (8 November '83)
"All is well on the NEKTON home front, We manage to have one of the subs dive every month of every other month. We're shooting for 100 dive-days per year. Most of the work this year has been biological surveys along pipeline routes or at platform sites.--DSPA is alive and well, too. As I'm sure you are aware, Tom, Will, and Nihil have been able to line up an interesting speaker for most of the meetings. --As of November 1, the Treasury is reasonably healthy. We maintained an average balance of about $1600 throughout the year. Present balance is $1723.20."

Will Forman--DSPA President (17 November '83)
"I just returned from our November lunch meeting. Our speaker was Tom Saunders, O-in-C of DSV TURTLE. He talked and showed slides of his recent visit to Toulon to see the French deep submergence people. He showed slides of CYANA during launch and recovery and described the new 20,000 ft. single-sphere boat SM 97 which is due for launch in about two years. It was very informative and interesting. I just phoned Brad Mooney and he agreed to try to be our speaker in February when he's out here. Lou Eyerly wants to speak in 19 January on the recovery of the SDV (?) plane. No meeting in December, but there is a combined MTS/DSPA Christmas party on 10 December.--We had nineteen people at this luncheon. It's interesting that the attendance hovers between 18 and 30 with good speakers and lots of early warning notice by way of the postcard notices.--I don't know for sure, but I think it was to him that I sent T-shirts and patches about two months ago.-- I have not moved yet. My tenants are having housing problems and I haven't the heart to kick them out because they are such good friends. --Tom Vetter received orders to duty at Groton, Connecticut, and is due to depart in December. We will need a new DSPA Secretary.--My solar installation is working like a charm even in the Southern Cal winter. I even planted a lawn last week, but it only looks like my hair in green so far!"

Will Forman--DSPA President (13 December '83)
"On 8 December '83, there was a meeting of the DSPA Board of Directors. Present were:

Will Forman-President	John Schiltz-Vice Pres.
Don Saner-Past Pres.	Gerald Shiller-Treasurer
Tom Vetter-Secretary	Tim Caffarella-Membership Committee Chair.
Nihil Smith-Speaker Coordinator	

The following items were discussed or decided:

(1) Caffarella will assumeduties of DSPA Secretary temporarily due to Vetters Navy transfer.

(2) Shiller will send dues notices in January '84.

(3) Schiltz will head an Ad Hoc Committee to: (a) review DSPA goals and functions, (b) review the DSPA Constitution and recommend offices and duties appropriate for Associate Members with possible Constitution changes in several areas. He will present an outline of committee intentions at 19 January lunch meeting.

(4) Lou Eyerly of Submarine Development Group One will give a presentation on 19 January on the attempted recovery of a Navy WWII SBD dive bomber.

(5) RAdm. Brad Mooney, Chief of Naval Research, will speak at the 15 February luncheon meeting on oceanography data collection from the space shuttle vehicles.

(6) The DSPA address list will be updated by addendum sheets as soon as replys and corrections are received (January). Members are urged to notify Forman, Caffarella, Saner, or Shiller of correctionsor changes in addresses. Suggest using Post Offise Form 3576 "Change of Address Card".

(7) Henceforth, the Newsletter, luncheon notices, and dues notices will be sent out by a custom mailing service. It costs $15 labor for Newsletter, $5 for the local luncheon notices, $15 for dues notices, plus about $25 to set up two sets of lists for labels. These costs do not include material, mailing, and repro which we pay for anyway we do it. My best guess is we can have the Newsletter in the mail four days after receipt of the original from Editor Worthington.

(8) O-in-C SEACLIFF has invited DSPA Members for a tour of SEACLIFF in March after return to San Diego from reassembly with th e new titanium sphere.

(9) Ageneral discussion was held on how to increase the DSPA image, prestige or proffessional standing, and ,therefore, overall effectiveness. There was a lot of philosophy, but it was acknowledged that we need more high quality contributors to the Newsletter. Bob Worthington has been begging for contl ibutions since Day One. Aspecific implementation came out of the brain storming, and that was to make specific requests to project managers and pilots with editorial and format assistance supplied. Also, it was suggested that more mutually hosted events be planned such as MTS/DSPA, ROV '84/DSPA, and IUPA/DSPA, etc.

As President, I will be glad to make specific requests for info, but I need the membership's help."

Discovery Bay Foundation To Lease Three-Man Sub

The Discovery Bay (Jamaica) Research Foundation recently signed a three-year lease with Research Submersibles Ltd. of Grand Cayman, British West Indies, for the use of a Perry PC8-B submersible.

The PC8-B, a three-man observation, 224-m A.B.S. classified submersible, will be operated from the University of West Indies' marine laboratory in Discovery Bay. Among the distinguishing features on the PC8-B are a manipulator, cameras and a 36-inch hemispherical forward viewpoint. The sub will be made available to marine researchers, student groups and visitors.

Larry Megow--Hahn & Clay (11 November '83)
"Some of our divers should be interested in this artificial gill!"

'Artificial gill' for humans unveiled

The Houston Post/Thurs., Nov. 10, 1983

Bonaventuras and container

BEAUFORT, N.C. (UPI) — Duke University researchers announced Wednesday development of an "artificial gill" process in which oxygen is extracted from water, theoretically permitting humans to stay underwater indefinitely.

Dr. Joseph Bonaventura, director of the Duke Marine Biomedical Center, and his wife, Celia, a biochemist, said they have developed a "hemosponge" that could replace current methods of providing oxygen to people underwater.

The Bonaventuras said they will continue their basic research and expect to bring the hemosponge to the stage of a "laboratory demonstration unit." They said the process "provides the potential for opening up for exploration regions of the ocean never accessible before."

Bonaventura said the hemosponge uses hemoglobin, the blood component in humans that carries oxygen from the lungs to all parts of the body. The hemoglobin is combined with a prepolymer — a substance with the consistency and color of golden honey — to form a sponge substance similar to that in seat cushions.

Bonaventura said the hemosponge is placed in a container. When water is passed through the container, oxygen is extracted.

Bonaventura said a container three feet in diameter by nine to 10 feet in length theoretically could provide oxygen to 150 people on the ocean floor.

Bonaventura said blood for the widespread use of the hemosponge could be obtained from slaughter houses.

Larry Megow-- Hahn & Clay (15 November '83)
"If you hear anything about the bad diving bell accident that killed five divers on November 1983 in the North Sea near Aberdeen, Scotland, let me know. I would be very much interested to know what type of 'clamp' was being used and what made if fail."

Sunday, November 6, 1983

Diving accident in North Sea kills five

ABERDEEN, Scotland (AP) — A diving bell accidentally broke away from a decompression chamber Saturday in the North Sea oil fields, killing four divers and a technician, a company official said.

Harry MacMillan, a spokesman for Comex Diving Co. in Aberdeen, said the divers — two Norwegians and two Britons — had just been brought to the surface after work on the Byford Dolphin rig in the Norway's northeast Frigg field when the accident occurred.

The bell had been clamped to the deck of a decompression chamber, MacMillan said. "During the transfer of the divers from the bell to the chamber, there was an accidental separation of the bell from the chamber."

The ensuing rapid decompression killed the four divers, he said. Two British diving technicians working outside the chamber were seriously injured and one of them died en route to a hospital in Stavanger, Norway, he said.

The spokesman said the divers had been working at a depth of 280 feet, performing routine maintenance in pressures roughly nine times the sea-level atmosphere.

Divers who have been working at great depths must undergo a gradual decompression process before returning to normal atmosphere. The process allows oxygen dissolved in the blood to be slowly released.

Rapid decompression — often called "the bends" — causes bubbles to form, blocking the blood flow and causing pain, paralysis and death. Those killed were all Comex employees.

MacMillan said an "intensive inquiry" was under way to determine the cause of the accident.

Hybrid Electro-Optical Underwater Connector
Rugged pressure-balanced subsea connector contains one low-loss single or multi-mode optical circuit, two 600-volt 50-amp electrical contacts; can be mated and demated repeatedly at any ocean depth. Challenger Marine Connectors Ltd.

New Buoyancy Material
High-pressure, closed-cell PVC foam; underwater features include positive buoyancy of 19 kgs, good depth capability; economic pricing makes it an alternative to syntactic foam. Plastic Supply and Fabrication

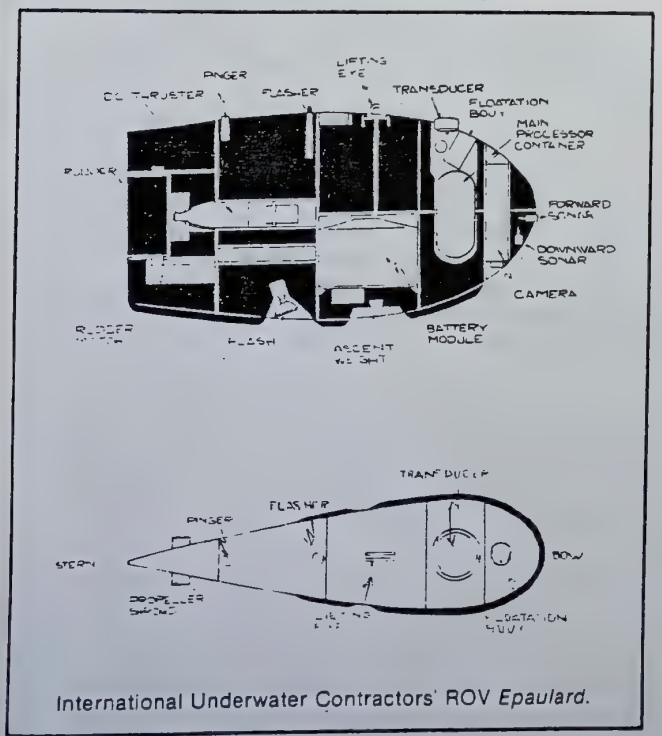
Epaulard ROV Used in NOAA Polymetallic Sulfide Research

By Eric Galerne
International Underwater Contractors, Inc.
City Island, New York

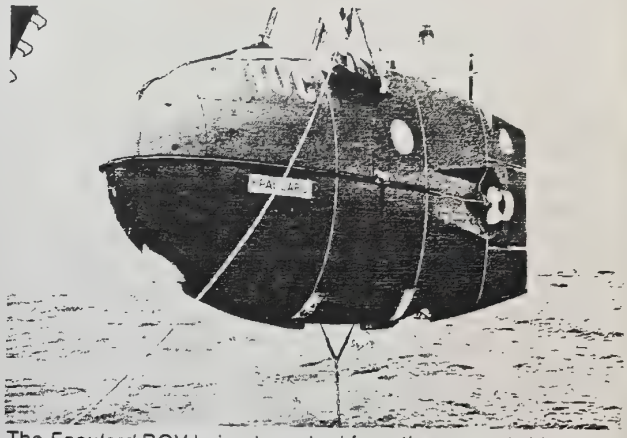
The same space-age technology of unmanned robotics that is currently being used to explore the heavens is now being applied to exploring the earth's greatest unknown resource, the Ocean.

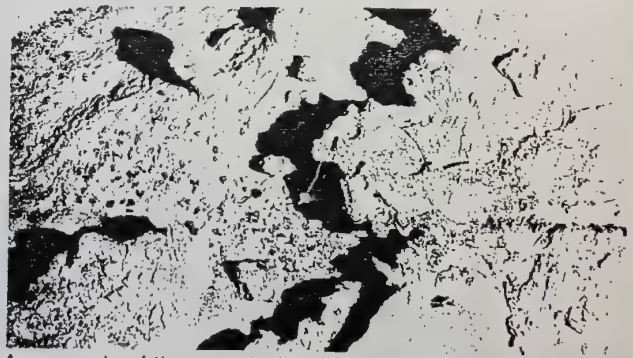
During a recent deep ocean research expedition, conducted by International Underwater Contractors (IUC) under contract to the National Oceanic and Atmospheric Administration (NOAA), an important research project utilized the world's deepest, unmanned, untethered vehicle called the *Epaulard*. The *Epaulard* was built by ECA, a French vehicle manufacturer, under the direction and according to the specifications of CNEXO (Centre National pour L' Exploitation des Ocean).

This Remotely Operated Vehicle (ROV) is capable of descending to 6100 meters; conducting a straight, grid or complex pattern survey over 12 nautical miles while taking 5000 high-quality black white photographs; and then ascending to the surface for recovery. It uses the latest in microprocessor technology to control its on-board components which include a forward obstacle-avoidance sonar, a downward obstacle-avoidance sonar, main forward thruster, rudder control, high resolution 35 mm still camera with flash, and acoustic pinger. These components are linked to the surface through a sophisticated acoustic telemetry system which allows communication to and from the surface and surface interrogation of the vehicle status.



International Underwater Contractors' ROV *Epaulard*.


The *Epaulard* ROV being launched from the support ship *Aloha*.


An example of the record of bottom features that the *Epaulard* provides. This photograph was taken in water several thousand meters deep.

The project took place this summer approximately 113 kilometers offshore Coos Bay, Oregon, in excess of 3600 meters of water. It was conducted in the area known as the Gorda Rift and the Juan de Fuca ridge where previous surveys have indicated the possibilities of significant amounts of polymetallic sulfides. Exploitation of these resources could prove to be a valuable and strategic source of critical metals used in manufacturing.

Previously, a research project was conducted on the Gorda Rift using a "Seabeam" mapping unit. This project showed distinct geophysical formations characteristic of active mid-ocean ridge segments.

Detailed bottom information and characteristics, however, were not confirmed by photographic means.

Specifically, the area to be photographed utilizing the *Epaulard* was in the northern end of the Gorda Rift where the ridge axis slopes 210 degrees. The goal was to photograph the central ridge, which extends along the axis of the rift (3-5 km wide). These photographs were to confirm and visually verify the Seabeam's high resolution bathymetric and tectonic map of the Gorda Rift. Due to its operational capabilities, the *Epaulard* was selected as the vehicle.

This was a new and challenging mission for the *Epaulard* and its crew as the system had not been designed for this type of seabed terrain. Conceived in 1976, this system was designed and built to photograph large, relatively flat areas containing manganese nodules, which operationally is a much easier task than "flying" above and around large valleys and cavernous cliff-type terrain that comprises the Gorda Rift.

The major concern of Henri Le Roux, chief operator of *Epaulard*, was that the vehicle might be required to enter a cave which would prevent its' acoustic "lifeline" from reaching the surface and vice versa. The *Epaulard* is programmed to drop part of its' ballast weight and ascend if communication with the surface is interrupted for more than 45 minutes. Normally this is a safety feature. However, in this new application it could mean the vehicle would find itself trapped on the roof of a cave leaving the crew on the surface helpless to retrieve it. Fortunately, this situation was never encountered.

The mission was considered a total success because the vehicle was able to take approximately 15,000 photos over its 5 day mission. After each dive, the negatives were immediately developed onboard IUC's support vessel *Aloha*. At this time the complete photographic recording is still being analyzed. This photographic record may be an important tool in determining the potential of this part of the ocean.

***Epaulard* Modifications**

In the fall of this year, the *Epaulard* will return to the factory for various modifications. The first will be the addition of a vertical bow thruster to enable the vehicle to climb over obstacles it encounters, rather than go around them as it does now.

Another will include the addition of a more powerful strobe light allowing the vehicle to take clear photographs at a higher altitude above the seabed.

A project currently under development is a new deep water television system for the real-time acoustical transmission of video information. Progress on this is moving swiftly and hopes are that it will be installed in the near future.

The technology that was developed in order for the *Epaulard* to exist and function has come a long way from the first ROV, the CURV vehicle launched in 1953. The addition of microcomputer circuitry and underwater acoustic technology has catapulted the "modern day" ocean observer deeper with greater precision than ever before. The *Epaulard* system is just the first of these unmanned, untethered "inner space" tools.

The increased use of the *Epaulard* and future generation vehicles will undoubtedly advance the quest for ocean knowledge and resources substantially. It is hoped that the knowledge gained with these tools will not only give us greater insight about our environment but will also benefit all mankind.

2W DIVERS TO THE RESCUE

Gales did not stop a 2W diving team from rescuing a man recently trapped on an ADS at the bottom of the North Sea. **Andy Griffiths** became stuck in his Mantis 308-feet down while inspecting a damaged riser near Amoco's Montrose Field, 120 miles east of Aberdeen. The 2W (Wharton Williams Taylor) team were heading for Peterhead aboard the dive support vessel *Maersk Defender* On October 19th for a crew change when the alarm was raised at 5 p.m. and the ship was ordered to head for the scene.

Six divers were in saturation aboard the *Defender*, including **Brian Hagan** who had earlier been working at the same damaged riser where the submarine was now trapped. As the *Defender* punched her way through the heavy seas, the rescue operation was made ready. By 10 p.m. that night, the diving team was ready for action. An hour later the vessel arrived on station beside the rig, *Western Pacesetter.*

2W diving superintendent **Rab Butler,** coordinator of the operation, decided **Brian Hagan** would do the rescue dive, with bellman **George Kent**. "Brian had been working at the riser and had a good idea of where to locate the submarine," Butler said.

And so it proved. The bell was lowered at 5 minutes past midnight on October 20th and 3 minutes later **Brian** had left the bell and was alongside the *Mantis*. He quickly pinpointed the problem. The *Mantis support cable was tightly wedged in a gusset on the nearby BOP stack. As* **Brian** tried to release it, the *Defender's* skipper, **Captain Ray Kuczaynski** struggled to keep his vessel on station, at times being edged to within 15 feet of the *Western Pacesetter* by 20-foot waves.

Butler, who was on the bridge alongside the captain when not in dive control, said a secondary cable was eventually lowered to the Mantis. Brian Hagan attached it to the submarine's emergency cable, then cut the snagged line to enable the recovery to be made. He then pulled the Mantis clear of the damaged riser to ensure a clear lift. At 1:25 AM Griffiths and his ADS were safely back on the rig. The 2W divers were lifted on to the *Defender* 20 minutes later. At 3 AM the ship was once more heading for Peterhead, mission completed.

IUC LIVEBOATS MANTIS FOR RECORD

IUC's MANTIS, a 1-atmosphere, 1-man, tethered vehicle, has just completed the world's deepest liveboat working dive offshore the USA's West Coast. The mission included a bottom videotape survey with 35mm photography and a bottom sampling program over a 6 mile proposed pipeline route at depths of 1,000 - 1,400 ft. This program was performed offshore California in the Santa Barbara Channel. The survey required MANTIS to fly above the seabed in addition to working on the bottom using its variable ballast. The MANTIS was supported by IUC's 143 ft. support vesel *ALOHA*, specifically designed to support liveboating operations with divers, ROVs or manned subs. MANTIS and *ALOHA* are operated and supported out of IUC's West Coast office in Santa Barbara, CA.

Undersea Explorer Claims 'Right Stuff'

Fort Lauderdale, Fla.

An oceanographer fed up with astronauts getting all the credit for "the right stuff" says he also faces an unconquered frontier — that could be more important to humanity.

Ian Koblick is an "aquanaut" who has pioneered undersea explorations, but aquanauts have won little glory, and no one has written a best-seller about them, such as Tom Wolfe's astronaut book, "The Right Stuff."

"Sure, the space program had accomplished a lot," Koblick said. "But I haven't seen it produce any food yet.

"The oceans could feed the world. The oceans could feed all the world's hungry and eliminate 80 percent of disease by providing a fresh water source, but because the seas don't have the military potential of space, the government isn't interested."

Koblick's interest in the oceans started as a teenager, when he took up scuba diving. He turned his hobby into a profession when he became part of the Tektite undersea research program in the Virgin Islands in 1969-70.

Tektite divers spent up to 650 days living in subsurface habitats, conducting marine experiments funded by government and private industry. When Tektite ended in 1970, the government got out of the project.

"We risked out lives for that program but it led nowhere," Koblick said. "We thought our programs were going to be the NASA of the seas but it didn't happen."

Since then, Koblick's love for the world's oceans and scientific curiosity have not waned. He has spawned idea after idea for research and money-making projects and has even implemented a few.

Armed with a $500,000 government grant, Koblick went down to the sea around Puerto Rico to study development of the sea's resources.

"I carried out the biggest, most successful underseas program in the world," Koblick said. His project was a 300,000-pound underwater habitat on the ocean floor.

Then in 1976, the government pulled the plug on Koblick's research. He remained undaunted.

He tried to sell his research ideas to the Carter administration, then took plans to Tallahassee, but state leaders wouldn't have it.

"I had bankers, legislators, all the backing I needed, but the state of Florida wasn't wise enough to give me even minimal support," said Koblick, who lives in Fort Lauderdale.

Associated Press

Sub Pilot Rescued

ABERDEEN, Scotland (AP) — The pilot of a one-man submarine working in Britain's North Sea oilfield was rescued Thursday after being trapped in his craft on the sea floor for eight hours, the Amoco Oil Co. reported.

An Amoco spokesman said the rescue effort began Wednesday night when a cable connecting the submarine to an oil rig became tangled beneath the water about 100 miles east of Aberdeen.

He said the diving support vessel Mersk Defender was dispatched to the rig, which Amoco operates.

Name Is Changed To Perry Offshore Inc.

Perry has a new name, a new organizational structure and record high sales for their fiscal year ending August 31, 1983. Formerly Perry Oceanographics, Inc., the new company, Perry Offshore, Inc., will retain the same management, personnel, facilities and business activities.

Henry (Hap) Perry, president, reports that the organizational structure is already working to make Perry Offshore more responsive to the new demands of the offshore industry. More than half of Perry's business is now in remote operated work systems including RECON® ROV's, ROV work packages and large special ROV work systems.

Bruce Crawford, vice president-marketing, attributes the record 1983 sales to the company's priority commitment to developing new ROV work applications technology and performance on special ROV projects.

Jon Newman, vice president-business development, adds that Perry's early commitment to the changeable work package concept is responsible for the market acceptance of the RECON's as "The Simpler Systems That Do More Work."

IUC'S MERMAID II, a 1,000 FSW 2-man sub has recently completed a successful mission for NOAA (National Oceanic and Atmospheric Administration) offshore Alaska in conjunction with the *ALOHA*, MERMAID II's purpose-built support vessel. The mission consisted of gathering fish and bottom samples while video taping the effects of drag-line fishing techniques on the seabed ecology. Stereo 35mm photos were also taken. Despite the frigid water temperature, the 23 day mission resulted in 52 dives completed with average bottom times per dive in excess of 3 hours. This demonstrated the reliability and capabilities of manned sub operations and especially of the MERMAIDII/*ALOHA* package which is now back in Santa Barbara, CA.

))) ***Atlantis II* is New Mother Ship for Submersible *Alvin*.** Launched in 1964, the three man submersible *Alvin* has operated from its mother ship *Lulu*, a 64-meter catamaran. Now the research vessel *Atlantis II* will take *Lulu's* place after an overhaul period during which an A frame will be installed on the stern to launch and retrieve the 16,330-kg submersible. A hangar will house it. *Alvin* is owned by the U.S. Navy and operated by the Woods Hole Oceanographic Institution (WHOI). About one-half of the conversion cost of $1.6 million is being funded by the National Science Foundation's Oceanographic Facilities Support Section and the remainder shared equally by the Office of Naval Research and National Oceanic and Atmospheric Administration (NOAA). *Atlantis II,* delivered in 1963, is owned by the National Science Foundation and operated by WHOI. *Alvin,* which slipped off *Lulu's* platform in 1969, sank in 1600 meters of water off New England and was retrieved three years later, then overhauled in 1973. A new titanium pressure sphere increased the depth capability from 1800 to 3700 meters. *Alvin* was the vehicle that took WHOI geologist Dr. Robert Ballard to seafloor spreading hot vents near the Galapagos Islands, discovering strange life forms and polymetallic sulphide mineral deposits. After the overhaul is complete the sub-ship team will leave on an 18-month cruise to conduct research in biological, chemical and physical oceanography; marine chemistry; and submarine geology and geophysics. *Lulu*'s fate is undecided, but she will probably be used in some sort of oceanographic research.

))) **Walsh Resigns USC Post, Forms Company.** Dr. Don Walsh, founder and director of the Institute for Marine and Coastal Studies (IMCS) of the University of Southern California (USC), resigned November 15. He has formed a firm, International Maritime, Inc., through which he will expand his consulting business, which has already taken him to Japan and Russia. His offices will be in the city of San Pedro, California. A member of the National Advisory Committee on Oceans and Atmosphere (NACOA), he will continue his active participation in many committee; professional society and advisory activities, he told *Sea Technology*. Walsh, a graduate of the U.S. Naval Academy, Class of 1954, was a submariner. He earned his Ph.D. degree in oceanography from Texas A&M University while on active duty. He is best known as being the co-holder of the world's depth record in the bathyscaphe *Trieste* to the bottom of the Challenger Deep of the Marianas Trench near Guam in the Pacific January 20, 1960. Depth: 10,912 meters (35,800 feet). The *Trieste* is now on display in the U.S. Naval Museum, U.S. Navy Yard, Washington, D.C.

))) **Navy Oceanographer Mooney Slated to be Chief of Naval Research.** Rear Admiral John B. "Brad" Mooney, Oceanographer of the Navy and director, Naval Oceanography Division, OP-952, under the Chief of Naval Operations, will become the Chief of Naval Research (CNR) October 31. He was nominated by the Department of Defense and the President for confirmation by the U.S. Senate. He will relieve Rear Admiral Leland S. Kollmorgen October 31. Kollmorgen will retire. Mooney, 52, is a submariner and has been involved with the Navy's deep submergence program. As head of the Office of Naval Research (ONR), Mooney will have in his command the huge Naval Research Laboratory in Washington and control of substantial funding for contract research in the academic community, institutions and industry covering the scientific spectrum. The CNR billet differs from most other flag officer assignments in that it exists under a separate statute. That law says that a rear admiral (upper half), rear admiral (lower half), captain or commander can be appointed to the two star post for a three year term. U.S. Senate confirmation is required. The lower half rear admiral rank is being phased out and the one star rank of commodore is being phased in. The Office of Naval Research is located in Arlington, Virginia and employs some 400 persons on the headquarters staff.

John Richard (Rich) Seesholtz, Captain, USN, is the new Oceanographer of the Navy and director, Naval Oceanography Division, OP-952. In addition to his other new duties, Capt. Seesholtz will assume the helm for *Oceans '84*.

Swiss company introduces very small sub

MARKASUB UNDERWATER Services of Basel, Switzerland, is now marketing its E2, a flexible, free-swimming, one-man work submersible for 210 meters of water.

The baby-sub E2 can be carried rapidly, easily and at low cost by the standard commercial transport to work sites around the world. According to Markasub, the E2 is the only autonomous submersible on the market which can be transported ready for work in the cargo compartment of the passenger aircraft B-747-257B and DC-10-30.

The company says the steering of the E2 allows the operator to carry out a broad range of subsea tasks in the areas of observation, inspection, location as well as general diver assistance and underwater research.

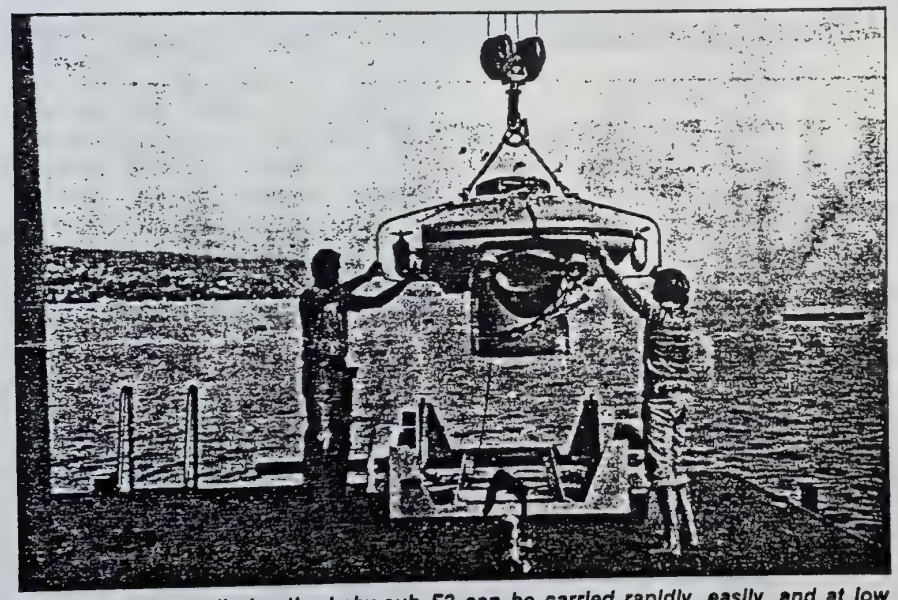
The E2 has been developed predominantly for the offshore industry. Since it can be equipped with various manipulators, tools, samplers or any other devices, it is particularly suitable for survey and inspection of pipelines and offshore drilling rigs.

The elliptical steel pressure hull with a domed acrylic viewport in the bow and a hemispherical acrylic dome on top, the supply unit located below it, the GRP-floats and the laterally placed motors form the characteristic construction features of the E2.

The flange of the acrylic dome is made of anodized seawater-resistant cast aluminium. All movable penetrators (motors, manipulators, safety-ballast) are made of stainless steel, sealed by two o-rings.

An additional acrylic dome, which does not form part of the pressure hull, protects the main dome against knocks and scratches. The two blind flanges can be fitted out with a tool exchange system and other devices which are necessary to carry out a broad range of subsea tasks.

The ballast jettison of 60 kg can be dropped manually as well as automatically (operating on the deadman principle and/or on exceeding the depth limit).The E3 is a free-swimming, two-man sub for 260 meters of water. Its prototype, the submersible Geo, was built in the summer of 1981 for Hans Fricke, a German scientist, for his scientific research in the Red Sea. During its more than 200 dives, the general conception proved to be very successful.



Because of its small size the baby-sub E2 can be carried rapidly, easily, and at low cost by the standard commercial transport to work sites around the world.

New sub to handle support chores

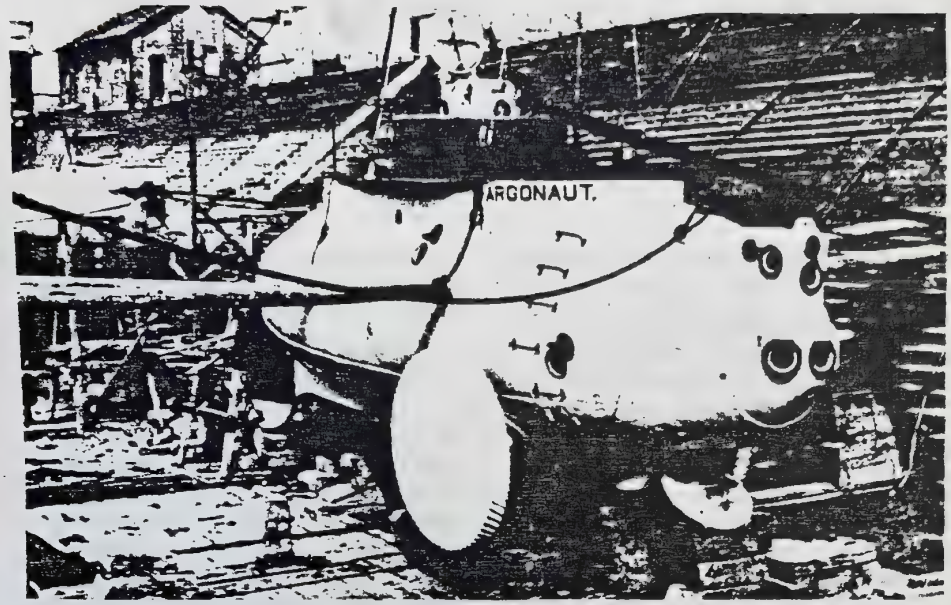
A SURFACE-INDEPENDENT, multi-capability submarine is being fabricated by Bruker Meerestechnik GMBH of West Germany to undertake a variety of inspection and exploration support tasks. It is scheduled to begin operations this summer.

The vessel has an operational depth of about 200 meters and a displacement of 50 tons. The submarine, named Seahorse II, will support a 4 to 6 person crew for seven days of operation with a range of 100 nautical miles submerged.

The propulsion plant works on a hydraulic system, powered by diesel or battery-powered electric motors, depending on whether the submarine is submerged or not. In the hovering mode, bow thrusters, stern thrusters, and retractable vertical thrusters serve for dynamic positioning.

The vessel will have a hemispherical bow section and conical stern, with a conning tower and a large spherical bow viewport. Ballst tanks for compensation of buoyancy and different weight of equipment, crew and fuel will be installed outside and inside the submarine. The vessel is 13 meters long, 2.2 meters wide and 3.6 meters high.

THE OTHER ARGONAUT WITH WHEELS YET . .



In 1896 the keel of another Argonaut was laid at the Columbian Iron Works, later to be called the Ft. McHenry shipyard, or the Lower Yard, as the yards present owner, Bethlehem Steel, calls it, in Baltimore's Inner Harbor area.

This Argonaut was launched in July 1897 and commissioned 19 Aug 1897. It was 36 feet long, had a 9 foot beam and displaced 90 tons. The boat was better called a research vessel and was developed by Simon Lake. Lake designed it to be a commercial salvage vessel.

And it had wheels to travel along the ocean floor. Its three wheels were powered by a 30 HP internal combustion engine that was designed for ten hours continuous submergence. A forward air lock hatch (see hatch ajar, forward, under portholes in photo) was designed to allow a diver to leave the submerged vehicle.

And it had a snorkel. This was a long rubber hose, suspended above the water's surface with buoys, which supplied air for the engine.

Mr. Lake demonstrated his boat but could find no backer. After its few demonstration cruises its history is lost.

In photo, see large starboard wheel, edge of port wheel outboard of air lock hatch, and third wheel sections, astern. What appears to be another submarine astern in the drydock, is unidentified.

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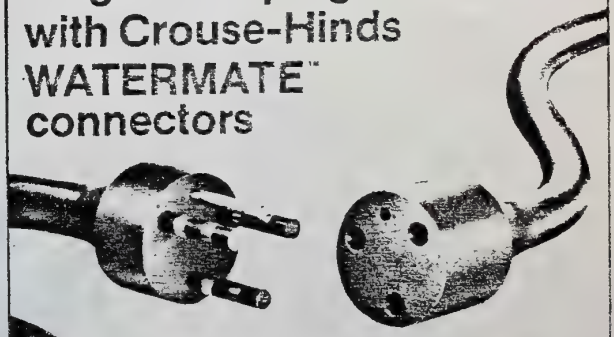

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USS Monitor Anchor Recovered After 120 Years Submerged

After five frustrating days on-site plus some 2½ hours of "overtime," the distinctive four-fluked anchor from the Civil War ironclad *USS Monitor* finally made it to the deck of the *R/V Johnson.*

It was a fitting culmination to an expedition beset by lousy weather, high seas, lousy weather, poor underwater visibility, lousy weather and plain bad luck.

The historic anchor, with 2 meters of chain still attached, is the largest artifact recovered so far from the marine sanctuary where the *Monitor* lies upside down in 64 meters of water some 25 kilometers south-southeast of Cape Hatteras, North Carolina.

In the water off the Outer Banks for over 120 years since the *Monitor* sank in a New Year's Eve storm in 1862, the anchor now resides in a water-filled tank on East Carolina University's Greenville, North Carolina, campus under the watchful eye of Curtiss Peterson of the *Monitor* Technical Advisory Committee.

Participants in the mission to raise the anchor included Harbor Branch Foundation Inc., Fort Pierce, Florida; the National Oceanic and Atmospheric Administration (NOAA) and the East Carolina University Program in Maritime History and Underwater Research.

Harbor Branch furnished the diving and submersible support vessel *R/V Johnson;* the diver lockout submersible *Johnson-Sea-Link I (JSL-I);* and associated personnel to operate them. NOAA, legal guardian of the 64-m deep *Monitor* wreck site since it was declared a national marine sanctuary in 1977, furnished $45,000 toward the mission's expense. Dr. Nancy Foster, chief of the Marine and Estuarine Sanctuaries Program of NOAA's Office of Ocean and Coastal Resource Management, represented NOAA on board the *R/V Johnson* during the mission.

The expedition, a follow-on to two previous summer study projects at the *Monitor* site (See *Sea Technology* for September 1977, page 29 and October 1979, pages 22 and 39), had multiple goals, some relating to long-term feasibility of bringing up the vessel's distinctive turret or even salvaging the vessel piece by piece, but the objective of lifting the anchor was the one that captivated most observers.

The sight of the four-fluked anchor, with a two-meter length of chain still attached, resting on the deck of the *R/V Johnson* was one that appealed to those present on a number of levels—for reasons pertaining to underwater archeology, maritime and military history and ocean engineering.

The skills demanded by the mission to recover the anchor are commonly found in the field of underwater salvage—underwater cutting, diving, video documentation and rigging. But the payload of this particular project held more than passing interest for participants in the salvage effort. The anchor measures 1.2 meters across and was designed to be housed in the *Monitor's* cylindrical anchor well. The well-and-anchor system, like the *Monitor* herself, was designed by Swedish-born engineer and inventor John Ericsson.

Some 2 meters of anchor chain still is attached to the anchor. A Broco burning bar took 15 minutes to cut through the links to free the anchor for recovery.

Sequence of Events

The *R/V Johnson* arrived on station over the wreck site on Sunday, August 21, and launched the 6-meter long submersible *JSL-I.* Harbor Branch Operations Division Director Roger Cook told *Sea Technology,* "The first sonar pass, using a Straza Model 250 sonar, revealed a 55-gallon drum, some of the usual seafloor debris, and two

flukes of the *Monitor's* anchor, sticking up out of the sand." The anchor was found about 50 meters southwest of the wreck. Harbor Branch had reasoned that it would be in this location from knowing the direction of the wind on the stormy night the ship sank.

The first divers who locked out of the submersible were hampered by extremely poor visibility ("a few centimeters," said one source.) It took some time to jet away enough sand to expose about 3 meters of the anchor chain. The *JSL-I's* powerful bow thruster was used to accomplish this.

A Broco cutting rod, commonly used in commercial diving operations, sliced through the 2.7 cm stud-link anchor chain in about 15 minutes. Aside from limited visibility, this part of the operation went fairly smoothly, due in part to practice sessions held by Harbor Branch technicians in the more hospitable waters of the Bahamas, close to the institute's Florida headquarters.

Freed of the weight of the rest of the chain, the anchor was more liftable. On August 24 a diver attached a sling to connect the anchor to a lift bag with 1800 kg lift capacity. The bag was inflated from inside the submersible by pilot Tim Askew and began to rise toward the waiting support ship *Johnson*.

The "trip" was a short one, as the lift bag unexpectedly ruptured. After achieving a height-above-bottom of about 6 meters, the anchor fell back to the bottom, coming to rest about 10 meters from its original location.

This development coincided with deteriorating weather, a specialty of the Cape Hatteras area, and operations had to be suspended due to waves of 3 meters and winds of 20 knots and more. Harbor Branch resources previously had been committed to a National Marine Fisheries Service project location nearby after the five days of the *Monitor* mission, and it appeared that anchor retrieval might have to wait for another year. Fortunately, Harbor Branch's schedule was modified—with some help from NOAA Administrator John Byrne, ultimate "customer" for both projects—and time was made to make one further attempt to raise the 590-kg relic.

Monday, August 29, dawned with wave conditions far more conducive to submersible launch and a possible anchor retrieval. Subsea visibility was 4.5 to 6 meters, vs. the earlier "few centimeters." Harbor Branch on-scene operations coordinator Jeff Prentice said that the recovery operation went "like clockwork." The manipulator arm of the *JSL I* was operated by chief submersible pilot Tim Askew and it placed an arrangement of a sling and two lift bags, capacities of 453 kg and 1800 kg respectively ("two just to make sure"), inflated them from inside the submersible and sent them up. Ascent time was 21 seconds and the anchor was on the deck of the *Johnson* within five minutes after breaking the surface. It was hoisted aboard by a crane located on the *Johnson's bow*.

The Future

NOAA's Dr. Nancy Foster told *Sea Technology* that due to the bad weather and resulting delays, some portions of the mission that pertained to looking at feasibility of raising the vessel's turret and possibly parts of the entire vessel (for subsequent "reassembly" on the surface) were not accomplished and would have to be examined in a 1984 return to the *Monitor* site.

In the meantime, on September 2 the anchor was delivered to North Carolina state archeologist Gordon Watts at Morehead City for overland transfer to archeological preservation facilities at the Greenville, North Carolina campus of East Carolina University.

Plans for subsequent display of the artifact have not been announced, but preservation procedures are expected to last more than a year.

Harbor Branch Foundation Has Active Research Summer

Based in Fort Pierce, Florida, Harbor Branch Foundation, Inc., employs manned and remotely operated vehicles in the course of its research in the marine sciences and development of tools to further this exploration. Harbor Branch operates the two manned, diver lockout submersibles *Johnson-Sea-Link I* and *-II*.

Between July 5 and September 19, Harbor Branch completed its longest scientific cruise of the submersible support ship *R/V Johnson*. Highlights of the extended cruise was the retrieval on August 29 of the 590-kg anchor from the *USS Monitor*, Civil War ironclad vessel sunk off Cape Hatteras, North Carolina, in 1962.

By the end of the year, Harbor Branch expects to have made a total of more than 200 dives with *Johnson-Sea-Link I* and more than 100 with *Johnson-Sea-Link II*. This represents a 50% increase in activity over 1982's comparable figures.

In the 78-day deployment of the *Johnson*, scientists joined forces with 31 counterparts from nine participating organizations working their way south from Boothbay Harbor, Maine, to Charleston, South Carolina.

NR-1 Nuclear Submersible Set To Explore Reykjanes Ridge

The U.S. Navy's only nuclear powered research submersible, *NR-1*, next summer is scheduled to conduct an exhaustive exploration of the undersea Reykjanes Ridge that stretches 770 nautical miles southwest of Iceland. Preliminary trial runs were made in the Bahamas in November.

The ridge is an elevated portion of the mid-Atlantic Ridge with some areas as shallow as 1000 meters below the surface. It holds strategic implications because the deeps on each side serve as undersea highways for Russian submarines transiting from or to the Murmansk area. A Russian proposal made in late 1980 was to hold a joint exploration expedition using the Navy-owned, Woods Hole Oceanographic Institution (WHOI) operated submersible *Alvin*. The U.S. Navy brought pressure to bear that resulted in the U.S. scientists declining the invitation. (Details in *Sea Technology* for March 1981, page 7.)

Participating in both the trials and the exploration is geologist Dr. Robert Ballard, discoverer of hot spots along the seafloor spreading mid-Atlantic Ridge and near the Galapagos Islands in the Pacific.

DEEP OFFSHORE TECHNOLOGY held its 2nd conference & exhibition 17 - 19 October in the Mediterranean Conference Centre, Valleta, Malta. Authors from Canada, Denmark, France, FRG, India, Italy, Monaco, Netherlands, Norway, Spain, Tunisia, USA & UK presented papers. Excerpts:

• **Drew Michel**, Taylor Diving predicted, "Before this decade is over, single task ROVs will assume a bewildering variety of shapes and sizes. The observation ROV will evolve into a true information gathering machine carrying low light level, high resolution color stereo television, and possibly 3-D sonar holography for muddy water. Beyond that, it will transmit water temperature, salinity, content of minerals, content of hydrocarbons, plus the azimuth and velocity of current at the cage and at the vehicle. At the moment, it is arguable whether the required power will be carried by an umbilical or if improved batteries will permit self-contained power."

And, "The ultimate ROV of the late 1980's, however, will be what my friend and colleague, **William W. Walker**, refers to as the Tele-Operated Man Substitute or TOMS. TOMS will function in the ultra-deep environment in the same manner that the deep sea diver currently serves the industry. As a matter of fact, the controller of TOMS most probably will be a trained, experienced diver. TOMS will be designed so the operator can make the mental shift, or translocation, from his control station into the vehicle. A few of the very best ROV operators are able to translocate, or mentally crawl into the machines. The operation of the machine becomes, to them, a second nature extension of the man. He is the machine.

• **Drs. Giran & Fructus**, COMEX ("Limits of Human Diving: Still a Mystery"), concluded that "it seems quite difficult for the time being to set a limit of safe and efficient human diving based on scientific observations. Apart from atmospheric diving techniques, it is probably true that the limit will be the check point of two different approaches:

–technological improvements in subsea robots which might slowly replace the diver.
–financial costs of very deep human diving which are not linear versus depth but probably exponential."

• **Gerard Guerrier**, COMEX, pointed out that ROVs practically put manned subs out of business in the North Sea but "it was such fun for the customer to go down himself rather than listen to laconic reports from divers." He concluded that *"Argyronete*, which COMEX is developing, could become the front runner of a new generation of subs: autononomous lock-out submarines (ALOS)." He acknowledged that COMEX is investigating highly stable hydrogen peroxide as a power source.

• **D. Coleman**, Mobil Oil R & D, reported on a deep water (2,500 ft.) production system with potential up to 6,500 ft. The concept involves:

–a subsea atmospheric system for 9 wells.
–a deep water flow line.
–a subsea atmospheric riser manifold.
–a deep water compliant riser.
–a floating production facility (a moored vessel)
–a manned sub for transport of people and materials, as well as for observation & inspection and auxiliary maintenance.

Many advantages he notes. Disadvantages? "Its manned entry presents the same kind of personnel risk as for any manned underwater vessel. This, however, is much safer than the use of divers and more reliable than the use of remotely operated tools." (*SubNotes* bets that **Bill Walker** of AMETEK/Offshore would have a hard choice of working on TOMS or this new sub for Mobil, if he were given the choice.)

• **Gary Campbell**, Chevron O.L, Spain, described the 1980-83 Facility Planning Program for the development of a deep water (2,475 ft.) marginally sized oil field in the Spanish Mediterranean. about ROV operations he reported, "A SCORPIO ROV visually checked the entire flowline route and performed penetration probes with a 1 m. calibrated small pipe for relative comparison of surface strength. Visibility was clear on the bottom with ROV lights and disturbed sediments were rapidly dispersed with the 13 cm/sec (¼ kt.) bottom currents. The SCORPIO ROV was operated quite satisfactorily from a converted ex-North Sea trawler with joy stick control of thrusters and main propulsion. The ROV was free swimming with no garage and landed directly on the original exploratory well in 754 m. of water using 915 m. (3,000 ft.) of umbilical. The ROV held position on the well and measurements were taken for orientation. These measurements confirmed the same vertical well angle as when it was originally drilled. This meant that there was no evidence of downslope pressure on the surface conductor which would cause lateral deflection."

• **J. Brommer**, Shell UK EXPRO, on the Underwater Manifold Center in the Cormorant Field: "Another aspect of the subsea completions is the increased use of ROVs. There are now a number of ROVs with manipulators available which can be used for a variety of jobs. Extensive use was made of ROVs to observe landing and retrieval of equipment on the UMC, clearance of debris, cutting of wires, etc. ROVs were also deployed during the remote pull-ins of flow and control lines to the UMC. They are now considered an invaluable aid for subsea completions, particularly for observation."

• **Mike Jones**, Mike Jones & Associates: "The future trend in underwater work systems is likely to be an increased use of ROV systems with improved task capabilities and specially developed work systems. These systems, however, will have to be integrated with the subsea production system at the conceptual design stage."

• **Stener Irgens**, NUTEC, outlined plans to exploit the Norwegian fjords for deepwater underwater technology testing. NUTEC already offers ROV pilot training from its *NUTEC FJORDBASE* research vessel. So far 23 pilots for Stolt-Nielsen Seaway Submersibles have gone through the program.

• **G. Hutchinson**, BP Int'l, described development of a novel seabed vehicle and plough which has been successfully used to bury the Magnus flowlines and control umbilicals.

• **Dominique Girard**, CNEXO, gave a full run-down on the new SM 97 20,000 ft. manned sub.

There were 3 volumes of 60 papers presented at the show. Recommended reading.

DID YOU KNOW that the Russian word for truth is "pravda," and that is the name of the official newspaper of the Communist Party of the Soviet Union? Perhaps that explains the expression, "Net pravdy v Pravde." We'll supply a translation if you need it.

SAN JOSE BOOTY TO BE SALVAGED

In 1708 the treasure ship *San Jose* and perhaps a dozen other ships set sail from western South America for Spain. It was loaded with gold, silver, emeralds or other valuable jewelry to revive the nearly bankrupt King Phillip V. After a week at sea, the fleet rounded a point of land at Cartagena, Columbia and ran into a 4-ship convoy commanded by the *HMS Expedition* which had been lying in wait in order to capture the *San Jose* and sister ship, *Almiranta*. *San Jose* tried to run through the British force but was sunk by gunfire. She sank in 800 ft. waters.

The loot on board is estimated to be worth $20 billion. That's right – $20 BILLION! The gold salvaged from *HMS Edinburgh* in 1981 was worth $125 million.

In the act again is 2W which could be working for a salvage syndicate headed by **Richard Wagner**, president of San Diego's Powerlast Corp. *National Geographic Magazine* has offered to film the salvage operation from a "photographic robot."

Wagner won't disclose the name of the syndicate because the deal isn't final with the Columbian government. Reportedly, a dymically-positioned DSV is on-scene along with a saturation diving team, ROVs and side scan sonar equipment. Wagner was quoted that about a half-dozen San Diegans are investors in the project, with each share expected to be worth $1.1 million, and that some own up to 50 shares. Unfortunately, *SubNotes* isn't one of them.

THE FURINO Side looking Sonar SL-16 consists of a 16-in. color display, transceiver unit with yaw stabilizer, processor/interface unit, a pair of transducers and junction boxes. Conventional side looking (or side scanning) sonars are mounted on a tow fish, but Furino has developed *hull mounted* transducers incorporating an electronic yaw stabilization technique for which a patent has been applied. The beam direction is automatically corrected by the heading information fed through the gyro compass. For further info about this and other Furino sonars, contact them at 9-52 Ashihara-cho, Nishinomiya City, Japan. Telex: 5644-498. Or Furino USA, P.O. Box 2343, South San Francisco, CA 94080; tel: (415) 873-9393.

OCEANEERING ACQUIRES SOLUS

In the biggest 1983 business news of the underwater community, on October 21st it was announced that Oceaneering International bought Solus Ocean Systems from parent Dallas-based Enserch. Reportedly, Enserch got 25% of Oceaneering stock and a seat on the OI board of directors. Just how Oceaneering's ROV arm (JERED) and SOLUS will co-exist is not clear at present. The move came as a complete surprise to SOLUS, JERED and Oceaneering employees and was apparently engineered at high corporate levels. *SubNotes* will report any reorganization if and when it occurs.

SUBMERSIBLE NEWS AND VIEWS

from IRENE FAGER

I had an interesting letter from LCDR R.W. Bowers, who is the Diving Officer on the HMCS CORMORANT. Cdr. Bowers says the SDL-1 is currently undergoing refit and certification. Part of the update includes the installation of a 36" acrylic dome at the Southwest Research Institute in Texas.

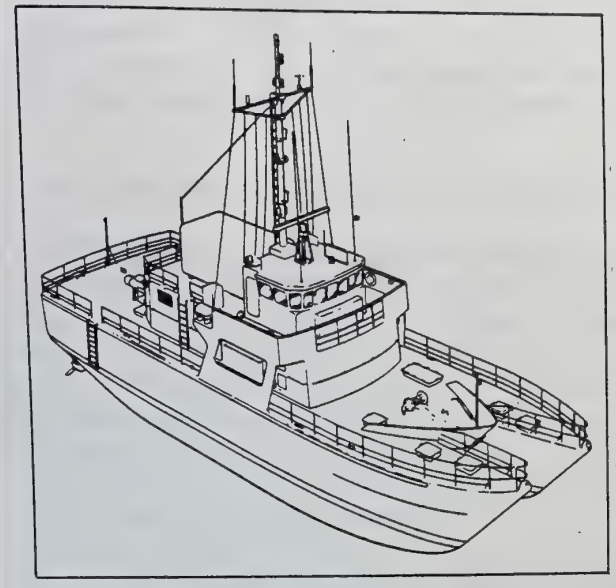
The CORMORANT has 20 divers, all of whom participate fully in SDL operations carrying out the duties of lock-out divers, launch and recovery system operators, submersible maintainers, and pilots. They currently have 3 qualified pilots including Chief Petty Officer Roger Boucher and Petty Officer Jim Larder. He didn't name the third pilot. They also have 3 pilots in training.

Cdr. Bowers says when they start diving again in about August 1984 they will be glad to do covers again. DO NOT sendyet. He also sent some info on CORMORANT and SDL-1 which I will print at a later date. Many thanks, Cdr. Bowers.

Ed Bland writes that the ALVIN/A II system may finally get going. As of Jan. 5 the new A-frame was being tested and if everything went well the ship was to leave about Jan. 17 for a series of dives on the Blake Plateau. The next series will be in the Florida Straits and the Northwest Providence Channel south of Grand Bahama Island. Then they will go to Tongue of the Ocean for some work on the AUTEC range. After these dives are all completed, hopefully by mid-February, the group will head for the Gulf of Mexico, with Tampa the port of call. So, at long last I'll get to meet the guys and see ALVIN and A II.

Ed says Dudley Foster is back again and pilots now are Foster, Hollis (Chief Pilot), Hardiman, and Collasius.

Construction Of Two RAN Minehunters Progressing At Carrington Slipways



Minehunter features catamaran hull, fiberglass and foam sandwich construction, and weapons systems by Krupp Atlas Electronik.

Earlier this year, after intensive design investigation and development, the Commonwealth of Australia Department of Defense placed a contract with Carrington Slipways Pty Ltd. for the construction of two prototype catamaran minehunters for the Royal Australian Navy. Each is 31 meters in length, 9 meters abeam, displaces 170 tons and has a speed of approximately 10 knots.

The catamaran design for a minehunter allows a unique combination of proven concepts to be used which include: (1) A catamaran hull form which provides a large stable working area, reduces pressure signature and allows machinery to be placed high in the ship to reduce magnetic and acoustic signatures, minimizing the risk of mine activation. (2) Foam sandwich construction which further reduces the noise signature, provides good thermal insulation, requires a minimum of maintenance and provides improved shock resistance. (3) Use of twin diesel engines of a single type, each simultaneously driving a generator for ship power and a hydraulic pump for transmission of power to the propulsion steering units, all mounted well above the water line. (4) A containerized weapons control system which utilizes the functions of the navigational sensors, the sonar and the precision navigation equipment to control a recoverable submersible mine disposal vehicle.

The vessels are being built in a special purpose facility. The storage areas for GRP materials and the construction areas are environmentally controlled within strict limits to provide optimum conditions for applications and curing.

The hull core is made up of high density PVC foam which is glued together on a male mold. The outer skin is then laminated and the shell turned and put into a cradle for lamination of the inner skin and installation of internal bulkheads, decks and other substructure.

The main deck core is laid up on a concave mold and the concave side of the foam laminated. The mold with the deck attached is then lifted, inverted, placed in position over the hull structure and secured. The deck mold is then removed and the upper side of the deck laminated and overlaid to the sides. The whole hull is then rotated through 180° to allow the lamination of the underside of both No. 1 and No. 2 decks. On completion of this operation the hull is turned again to the upright position.

The superstructure is assembled separately in the component area and installed as a unit following construction of the hull and upper deck.

GRP and foam sandwich components for construction and outfitting are manufactured in the component fabrication area. The hull is constructed in a 4-meter-deep construction dock which is fitted with lifting platform and turning mechanism to ensure that the hull can be lifted and rotated as necessary to achieve the best attitude for laminating activities.

NORTH SEA DIVE RECORD

What is believed to be a new record in the North Sea diving industry – the recovery of a blow-out preventor and associated debris weighing some 275 tons, lost in 1080 feet of water – is being claimed by Wilhelmsen Offshore Services and Wharton Williams Taylor (2W). A 9-man diving team using the Spider atmospheric diving system carried out the recovery in the Troll Field from the semi-sub rig *Treasure Saga*, for Saga Petroleum, in just 18 dives totaling 77 hours.

Saga Petroleum asked for a suitable recovery system and the response was swift. With very little preplanning and rapid mobilization, 2W assembled Spider and associated equipment for loading on to a supply boat at Aberdeen. Within 48 hours of the initial request, the ship was on location at *Treasure Saga*. Spider was installed in a congested cellar deck on board the rig but bad weather delayed the 1st dive. but in the course of the next 9 days, a series of dives were carried out in the complex operation. The task involved recovering 11 joints of marine riser, the slip joint, moving 2 joints some 20 feet clear, cutting the two pod lines and wires and finally the recovery of the BOP stack weighing 205 tons. The recovery was made more difficult by the stack being ²/₃ buried and lying 4 feet from the damaged guidebase.

The actual lift of the stack was carried out using 4 200-ton lifting strops through the upper main support frames and around the lower ram bodies. Two tugger lines were attached to the strops to maintain their position during the lift. The BOP stack was finally recovered in a 2-hour lift exactly 14 days after call out at just 6 hours' notice.

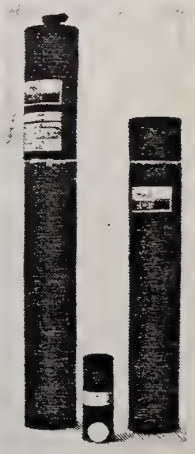
MODIFIED PINGERS TO WARN MILITARY SUBS TO REMAIN CLEAR OF OIL RIGS

Here's a new application for our Model 2390 Pinger. Modify it and then attach it to an offshore oil rig as a noise generator to warn military submarines to stay clear of the area. That's what Burman Exploration intends to do with pingers our specials engineering department in San Diego modified for our subsidiary in Aberdeen. They will ping at 9.5 kHz every four seconds for 100 milliseconds instead of the standard 12 kHz every two seconds for 10 milliseconds.

THREE-YEAR PINGERS SAVE MILLIONS OF DOLLARS FOR AT&T

AT&T is using nearly 30 Model 2400 Pingers to warn fishing boats and research vessels to remain clear of its trans-Atlantic cables. John Weidemuller, our East Coast rep, reports the acoustic beacons have been tuned to 50 kHz so that they can be detected by depth finders on foreign fishing boats operating in the western Atlantic. The pingers, equipped with three-year Model 1105 Battery Packs, are about a quarter of a mile apart and extend about 32 miles from shore. They are there to prevent accidental cuts in the cable which can cost $1½ million each to repair.

SPECIALS DEPARTMENT CREATES SPECIAL MINIPINGER



Looking for a MiniPinger? One housed in a cylinder measuring only 1.5 by 3.8 inches (3.8 by 9.7 centimeters)? We have it in the form of the Model 2610 recently created by our Specials Engineering Department. It's the small pinger shown in the accompanying photograph; a U.S. 25-cent piece is included for size comparison. The MiniPinger is powered by a self-contained 9-volt battery, transmits one mile (1.6 kilometer) at 9 kHz for 45 days and is rated to 5,000 feet (1,500 meters) in depth.

Also shown are a standard Model 1327 Pinger (right) and a Model 1327S which has been elongated to accommodate additional batteries to extend its life from 14 to 30 days. The connector on top is a power-loss feature which activates the pinger upon loss of main power to an ROV or submersible. Both 1327s are rated to 10,000 feet.

SONATECH, INC.

Designed for use where small size and light weight are required, the Sonatech Model NT-029 Acoustic Micro-Transponder has a choice of user selected options to suit a wide range of applications.

In the simple, single frequency version, it can serve as a well-head marker or be used for monitoring the location of an ROV. The addition of the Multi-Frequency switch option provides for twelve unique responses, allowing the NT-029 to operate in large transponder arrays, for instrument deployment or navigation. Optional releases (60 - 4000# load) provide for recovery on acoustic command.

The Acoustic Command option also permits the control of up to two external devices, such as valve actuators. Sonatech's exclusive command code system provides 380 unique codes ensuring maximum security and allows effective operation in high noise environments, as well as multi-path immunity.

Review & Forecast

Polymetallic Sulphides Spur Interest of Sea Mining

By John E. Flipse
Professor of Civil & Ocean Engineering
Texas A&M University

During 1983 the emphasis in ocean mining shifted from manganese nodules on the deep seabed to polymetallic sulphides (PMS) at the fast spreading centers of the earth's subsea crust. This interest was heightened by President Reagan's action establishing the United States' two hundred mile exclusive economic zone (EEZ).

It was followed by the prompt assertion by the Minerals Management Service (MMS) of the Department of Interior (DOI) that the EEZ is covered by the Outer Continental Shelf Lands Act (OCSLA), a new definition of the continental shelf. To use an oil-patch term, the "play" was accelerated by DOI Secretary Watt's valiant terminal effort to have the first successful hard mineral sale happen on "his watch."

These press-worthy activities were well served by two seminar/workshops which provided an excellent technical base and frank and open exchanges of information and perceptions between academia, industry and government on the PMS prospects.

The first meeting, held in January, was sponsored by NOAA and featured the several PMS discoveries in the Pacific including the Gorda Ridge "smokers" off the Washington and Oregon coasts which are partly within our EEZ, as well as those off Central America. Drs. Alexander Malahoff and Bob Ballard, among others, demonstrated their in-depth knowledge of PMS and their skill in catering to our "Cousteau Syndrome."

The mining industry expressed strong support for extended scientific investigation of the marine occurrences to help them better understand their terrestial deposits. The vast extent and potential cost of evaluation of these marine resources was noted, with concern.

The second meeting was held in November under the sponsorship of the MMS at Reston, Virginia. The science side was presented in an excellent exhibit adjacent to the lecture hall while the presentations focused on resource evaluation and development.

DOI's proprietary interest in the EEZ was obvious but continuation of close cooperation with NOAA was assured. Some concern was expressed regarding the suitability of the OCSLA for exploring, evaluating and developing these totally undefined deposits. An apparent consensus suggested that if "you had lots of faith" in our ever changing government, this route was at least as likely to succeed as new legislation.

The "doubters" gained comfort from the idea that by the time enough information was developed to make a sensible bid on a PMS deposit, say 10 to 20 years, the law could be amended to permit private enterprise development. It was agreed that a fundamental requirement for commercial development is a marked improvement of the metals market!

The major activity in the manganese nodule mining sector was the extended negotiations on the "claims" made by the several consortia under the Ocean Mining Act. We note, with regret, the diminution of development activity by Deepsea Ventures, Inc., the sole functioning survivor of the four original ocean mining ventures.

The rumors continue that American technology may be used by "Pioneer Developing Nation Ocean Miners" under the U.N. Law of the Sea Treaty in the development of national programs but, to date, no programs have been announced.

If we extend the definition of "ocean mining" to include dredging sand and gravel, and most reporters do, there has been some ocean mining in the high latitudes in support of petroleum exploration and development under the waters off Alaska. Most of this activity has been in waters under state jurisdiction, but MMS expects bids for these materials in their upcoming lease sale. The economic stimulus for this activity is real *if* the drilling program continues and artificial islands prove to be cost-effective.

When will other types of ocean mining "take off"? Not until we see dramatic improvement in the metal markets, a strategic need is painfully identified or a far-sighted nation looks well into the future. Hang in there, class of '87!

IUC ROV *Super Recon* Performs Offshore Work

International Underwater Contractor, Inc.'s *Super Recon*, the first in a series of remotely operated vehicles (ROV) designed to work at a depth of 700 meters, recently completed two offshore jobs.

Deployed from IUC's support vessel *Aloha*, *Super Recon* performed an inspection of the J-Tubes on Chevron's new pipeline from the California shore to the Edith platform in San Pedro Bay. Assisting the *Super Recon* was the IUC free-swimming submersible *Mermaid II*, which performed a detailed corrosive study of the pipeline at a depth of 76 meters.

More recently *Super Recon* was employed by Healy Tibbets to cut buoys connected to a new pipeline attached to Texaco's Habitat Platform. Using a specialized cutter to slice through double-strength nylon straps, *Super Recon* severed and recovered 700 buoys over a four-day period.

Future plans for *Super Recon* include the fitting of a sensory feedback manipulator for use in a site survey and geological sample gathering in 425-m. deep water off Santa Barbara, California.

'Artificial Gill' Could Lead To Submersible Power Source

A contract for the development of a power system utilizing oxygen extracted from seawater has been awarded to Makai Ocean Engineers, Inc., by Aquanautics Corporation. The power system will be used by both manned and unmanned submersibles and diver robots in their undersea exploration.

Claude Ganz, chairman of Aquanautics, said, "The award of this contract to Makai Ocean Engineers is the next step in developing technology acquired from Duke University. It also represents our expansion into promising high technology undersea businesses."

Last November 9th, Aquanautics purchased a patent held by researchers at the Duke University Marine Laboratory, Beaufort North Carolina, to a process designed to provide oxygen to man in underwater environments—an "artificial gill." The method, which extracts dissolved oxygen from seawater, is similar to that found in fish. The Bonaventuras' process combines results from basic research on such oxygen carriers as hemoglobin with the technique of immobilizing protein in polymer matrices or polyurethane sponges.

"We hope to have a ready supply of oxygen not only for divers, men in submarines and submersibles, but also for combustion and energy conversion to be used by exploration and testing apparatus at all depths," Ganz continued.

Dr. Joseph Van Rizen, president of Makai Ocean Engineers, explained that a power system which extracted oxygen from the sea around it could be three hundred times more efficient than batteries that are normally used to power submersibles. He pointed out that one of the units proposed by the Duke scientists would process about five hundred gallons of seawater per minute in order to develop one horsepower of energy. "I am very enthusiastic over the potential of this system," he said. "It could completely revolutionize underwater vehicles as we know them today."

Makai Ocean Engineers is located at Makapuu Point, Oahu, Hawaii. They have worked extensively in the development of undersea energy and in manned submersibles and undersea habitats.

Review & Forecast

ROV Business Down As Supply Overtakes Demand

By Michael Mulcahy
Manager, Washington Office,
AMETEK Straza Division

Depending on whether an underwater service contractor numbered his remotely operated vehicles (ROVs) in the busy half year or the idle half, 1983 was a year to remember or to forget. The slump that earlier had hit the commercial diving and manned submersible components of the undersea service industry finally has affected the ROV market.

Until recently this market was blissfully unaffected by the decreasing price in a barrel of oil—which ultimately pipes the tune for economic health of the offshore support business. At press time the OPEC barrel price of oil was $29.00, and could go even lower next spring. This compares to the high-water OPEC benchmark price of $34.00 in 1981.

In 1982 a reported total of 109 newly built ROVs entered the market place. In 1983 the total was approximately 60% of that level, or about 67 vehicles. The worldwide total of ROVs built in the last 30 years is about 367, according to one noted authority, Frank Busby. Day rates for active vehicle systems have plummeted in the last year, and systems that leased for $3,800 per day in 1982 were going for $1,700 in 1983—down by more than one-half.

This scenario was predictable, just as was the oversupply in drillrigs that developed in the mid-1970s. After unbridled spending for ROV acquisition, a period of austerity has set in for commercial ROVs. Companies who have fared best under these conditions have a product line diverse enough to encompass military as well as commercial business.

The 1983 summer commencement of work by the drill ship *Discoverer Seven Seas* in the Baltimore Canyon off the U.S. east coast heralds what may become a trend in the ROV business—specialization in drillship support. One manufacturer told the author that he anticipated pipeline inspection, until now a burgeoning application of ROV talent, being supplanted by drillship support as the offshore activity demanding the greatest concentration of ROV work.

At press time it appeared likely that the acquisition by Oceaneering International, Houston, of Solus Ocean Systems, Inc., would be approved by the U.S. government. This would make Oceaneering the largest commercial diving company in the U.S. and would marshall a formidable array of ROV resources and atmospheric diving systems (ADS) in one company.

It appears that the trend of acquiring pockets of expertise, to afford the acquiring company an instant—or greater—capacity in a given technical area, will contiue until there are comparatively few small companies left. The parent company offers the subsidiary an opportunity to underwrite capital asset accumulation in trade for some degree of loss of decision-making autonomy.

The future appears to hold several developments in store for companies participating in this critical sector of offshore technology. Since there is no ROV with all-purpose work and inspection capability, it appears probable that offshore contractors will buy a diverse array of vehicles, some purpose-built and others offering a wider range of utility.

Autonomous vehicles, after a considerable period of R&D which is still underway, appear to be closer to reality. One manufacturer has developed one for delivery this year to the Bedford Institute of Oceanography in Canada. Steady improvements should be made by manufacturers in the areas of tether management, thruster power, handling systems and manipulator dexterity. The temporary oversupply of vehicles should resolve itself by 1985, and vehicles will continue to supplant divers in undersea tasks that do not absolutely require human intervention. ◘

Change In Personnel Licensing Regulations For Commercial Ships Sought By U.S. Coast Guard

The Coast Guard is attempting to simplify and improve the licensing regulations for all commercial vessel personnel. The proposed amendments in CGD81-059 offer a license structure with career patterns for persons serving on all waters and on all kinds of vessels, from small passenger vessels to large oceangoing vessels. The proposed regulations also incorporate the requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW).

Major changes/key points: The notice proposes a simplified two license structure (Master/Mate and Chief Engineer/Assistant Engineer) on inland waters for service on any tonnage vessel and also for service on vessels up to 1,600 gross tons on near coastal waters (up to 200 miles offshore).

Trade restricted licenses would be eliminated—except for the restricted licenses established in law: uninspected towing and fishing vessels, pilot, motorboat operator, and non-navigating river mate.

Ocean operator and operator licenses will become masters and mates with route and tonnage limitations extended to 200 gross tons and near coastal waters.

License operators of uninspected towing vessels will be able to credit service toward obtaining master or mate licenses.

Special "industrial" licenses are established for officers who work on mobile offshore units.

Changes to requirements for a motorboat operator license will make it easier to obtain initially (on inland waters) and easier to use as a stepping stone to more advanced licenses.

The written exam subjects for the licenses have been standardized and would be listed in the new regulations. Consideration is being given to removing or limiting exam items on celestial navigation. Comments are specifically invited on this topic.

Exams for licenses would be required only at entry and command level.

When any license is renewed, the license holder would be required to complete an open book exercise (all of which could be done through the mail).

For persons who may have difficulty with written exams, the new rules would provide for oral exams administered under special circumstances.

Present license holders will be able to take advantage of the new structure when they renew their license or if they present information to the Coast Guard that justifies obtaining the new license earlier. (Note: If an officer is otherwise qualified to upgrade his license to a command level, he will have to take a partial exam on "command" topics).

The proposed regulations would allow substitution of simulator time or special training for underway service.

The proposed regulations would eliminate the special consideration given to former members of the armed forces regarding recency of experience.

The Coast Guard Regional Exam Centers will have more latitude in evaluating certain licensing matters.

Flow charts have been added to the regulations to illustrate the pattern of career advancement possible under the proposed rules.

Public comment period closes on December 6, 1983.

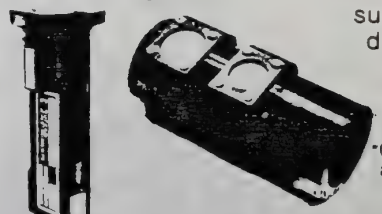
The complete proposed rule making appears in the Federal Register/Vol. 48, No. 153/Monday August 8, 1983.

If you have questions concerning the proposed regulations, contact LCDR **George Naccara** (202) 426-2240.

DEEPEYE* CAMERA SYSTEM

AUTOMATIC CAMERA FOR DEEP-SEA MINING AND CORING RESEARCH OPERATIONS

The DEEPEYE is a proven, general purpose camera system especially useful in photographic bottom survey work where free-drop grab systems and mechanically lowered box corers are used.



*Compatible with Preussag and Benthos grab systems

Length: 10.5" (267mm)
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- If camera malfunctions, simply throw it away and insert a new camera in its place (other cameras of this type must be returned to a repair station for repair and adjustment)
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ADVANTAGES

- Automatic built-in motor drive virtually eliminates misfire on deck or during descent to bottom
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- Simple on deck "story board" operation
- Low maintenance

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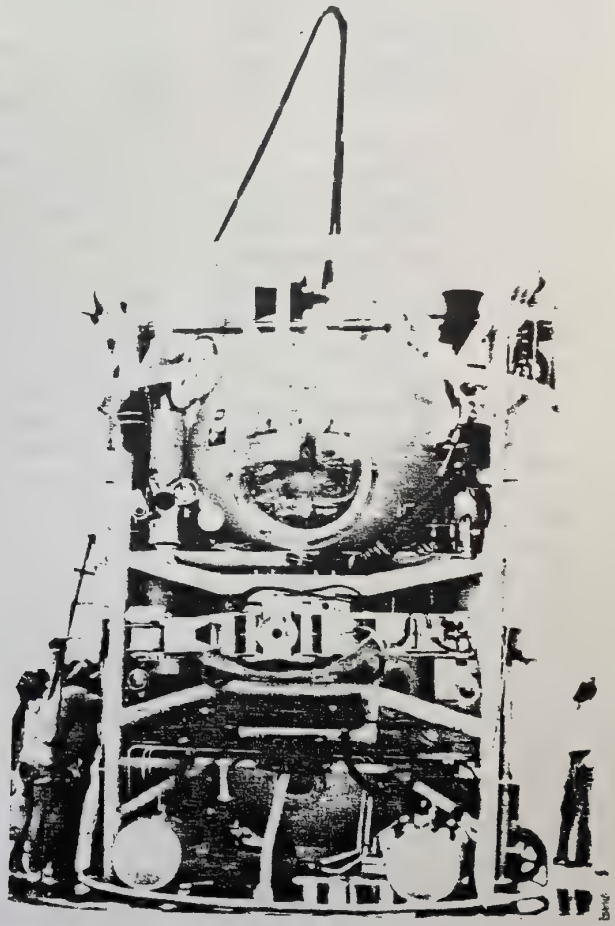
Combining Submersible/Diving Bell Capabilities
To Depths of 1000 FSW (305 MSW)**



- Three-man, 1-ATM observation/ control chamber with large panoramic viewport
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- Retractable legs for diver lockout on bottom
- Optional "bear-hugger" enables lockout while secured to mid-water structures
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- Surface control console provides video monitoring, communications and power switching
- Diving operations are controllable from surface or pilot chamber
- Battery pods supply emergency power
- Manual hydraulic release detaches umbilical in emergencies
- Tools, equipment available for many undersea work missions

PERRY OCEANOGRAPHICS, INC.

Ocean Engineering Has Arrived!

Soapbox

Dr. Raymond F. McAllister is professor of oceanography at Florida Atlantic University in Boca Raton, Florida. He is a marine geologist, diver, a tireless promoter of the "oceaneering" discipline and a prolific writer of professional papers and popular books about oceanography, including being co-editor of McGraw-Hill's Handbook of Ocean and Underwater Engineering. *McAllister also has produced and hosted television programs on oceanography in Galveston, Texas, and in Bermuda. He is listed in* American Men of Science, World Who's Who in Science *and in the* Dictionary of International Biography.

When ocean engineering was first listed as an academic discipline at Florida Atlantic University in 1965, naysayers suggested that this field of specialization should be taught only at the graduate level;that no one had heard of ocean engineering and the graduates would therefore have difficulty getting jobs; that there was no P.E. (Professional Engineer) in this new discipline; and, generally, that we were wasting our time.

We did not agree then and we do not agree now. Our first class got jobs and is deeply embedded in the upper echelons of many large companies.

Our graduates have come to be widely sought after by a variety of ocean-oriented industries and our graduates have established an international reputation. Ocean engineering is widely known throughout industry and a P.E. specialization in ocean engineering is now being prepared by the Florida Board of Professional Engineers.

Ocean engineering has arrived.

I have recently inquired about the status of "oceaneers" (ocean engineering alumni) at several of the institutions that have produced a total of 1500 bachelor level oceaneers, 500 to 600 masters graduates and about 125 PhDs. All tell me that their experiences parallel ours. Oceaneers are widely accepted by industry and government. The few companies which resisted hiring oceaneers have largely succumbed either to persuasion or, more often, after inadvertently getting an oceaneer secondhand from another organization. When they found that this new breed of engineers was indeed first class, they started recruiting directly.

One oft-repeated comment is that oceaneers don't know when to quit and turn out twice as much work as graduates of other engineering disciplines.

Perhaps this is because we try to stuff a strong engineering degree with additional oceanography, underwater acoustics, marine materials, corrosion and hydrodynamics into a four-year program. Only the very hard workers make it, and it takes several years to wind down from the habit of going full ahead.

Another question I asked was whether graduates went to ocean engineering jobs or made dramatic switches. All my respondents agreed that most went into ocean engineering. There was always the small percentage who stayed in the familiar surroundings of the college town, even if it meant changing disciplines. Interestingly, these people often did very well in other types of jobs, perhaps because they had learned how to study and the value of hard work. Some few changed direction entirely, entering family businesses, becoming scuba instructors in Cozumel, ministers, Peace Corps people, etc.

A few of the people who changed completely have returned to the fold; obtaining advanced degrees or taking ocean engineering positions even years later.

The negative side of the picture is equally important. Offshore oil, and the service companies which support it, have taken from 40 to 60% of the oceaneers graduated. Until the present recession, this generally resulted in a shortage of graduates, at all levels, with each new oceaneer getting multiple offers. Many, if not all, new graduates could choose the best combination of salary, area of interest within ocean engineering, benefits, quality of living in the area of choice, opportunity for advancement, travel (or non-travel if that was desirable), or opportunities for further schooling. This has changed in recent months, due to the generally depressed conditions in the oil and oil support industries.

Good students, B average or better, are still getting multiple offers from a wide selection of other employers but few are being chosen for the "oil patch."

The graduates with less satisfactory academic records must interview everyone who comes to campus. They must take full advantage of every lead and of cooperative education and summer OJT opportunities, both of which often lead to job offers.

No oceaneer, who is otherwise relatively normal, should have serious trouble obtaining a stimulating position in the industry. When oil demand picks up, as it must, this temporary setback, the first in 18 years, will disappear and all ocean engineering students will field multiple offers again.

Women oceaneers have been extremely successful, both in obtaining the positions they want and in advancing within their companies. This success probably reflects, in part, the desire for a female engineer on board, but multiple female hirings by the same company reflects the excellent record these women make.

Employment ranges across the gamut of ocean-oriented companies and agencies. There are oceaneers in essentially all military services, both as officers and civilian scientists. They are teaching at junior college and university levels in significant numbers. They hold positions in marine mining, the shipbuilding and repair industry and marine instrumentation companies as well as in management, sales, design, testing, inspection and service. They manufacture nuclear submarines, small submersibles, ROVs, military ocean hardware and scuba gear, blow-out protectors and wellheads, wire rope and fittings, North Sea anchors and soft fendering systems. A couple of them have been active in the Hawaiian OTEC (ocean thermal energy conversion) operations.

In short, they are involved across the entire range of ocean engineering tasks, basically in any job involving useful work in an ocean environment.

Indeed, ocean engineering is accepted. It is growing and it offers a fine, dependable future for hard-working, self-motivated young people.

FOUNDATION FOR THE PROMOTION OF THE ART OF NAVIGATION

A NON-PROFIT CORPORATION OF MARYLAND

P.O. BOX 1126, ROCKVILLE, MD

THOMAS D. DAVIES, PRESIDENT

DIRECTORS

THOMAS D. DAVIES
TERRY F. CARRAWAY
ROGER H. JONES
ERNEST B. BROWN
MEREDITH B. DAVIES

Dear Navigator:

A short time ago I wrote to you of my concern that the individual with navigation expertise was rapidly becoming an endangered species. I outlined the objective of our non-profit "Foundation for the Promotion of the Art of Navigation" and enclosed the first issue of the Navigator's Newsletter.

As a result of that initial mailing the Foundation is now established on a sound business footing. However to fully carry out our program of stimulation of interests we are expanding our membership. I am enclosing a copy of the second newsletter and again soliciting your support.

A membership form is attached which I hope that you will use. If you have friends with interest along navigation lines please pass this material along to them with our invitation to join.

Sincerely,

T. D. Davies

Yes, I would like to join the Foundation for the Promotion of the Art of Navigation. Enclosed is my tax deductible contribution of $25.00.

Name _____

Address _____

_____

"The art of navigation incites those who follow it to learn the secrets of the world."

— Christopher Columbus 1501

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

MAY, 1984

Vol. XVII, No. 2, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to deep submersible vehicle design, operations, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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Editor, DSPA
754 Buck Ave.
Vacaville, CA 95688
(707) 447-7235

or

Timothy P. Caffarella
Secretary, DSPA
5079 Brighton Ave.
San Diego, CA 92107
(619) 224-0143

Correspondence relative to DSPA operations, policy, and membership should be addressed to:

Willis Forman
President, DSPA
1527 Linwood St., Apt. #5
San Diego, CA 92103
(619) 295-0620

Timothy P. Caffarella
Membership Chairman, DSPA
5079 Brighton Ave.
San Diego, CA 92107
(619) 224-0143

EDITORIAL NOTES & COMMENTS

ROV '84 at San Diego, California, May 14-17, will provide some out-of-town DSPA Members an opportunity to attend the monthly luncheon on Thursday, 17 May, at Tarentino's on the waterfront. Unfortunately, this Newsletter will be a bit late for spreading the word, but I know that our Members are too smart to visit San Diego without checking in with Will Forman. Aren't you?

OCEANOLOGY INTERNATIONAL '84 was held at Brighton, England, 6-9 March. A report of matters of interest from any Member who was there will be appreciated.

OCEANUS is the fascinating oceanographic quarterly journal published by Woods Hole Oceanographic Institution. If you are not familiar with it, I recommend that you check it out.

As time goes on, I find the news of the underwater world in the trade magazines, etc., to be devoted to the unmanned vehicle. The obvious fallout is that I become completely dependent on Members for news of manned submersibles and their operations. We all like to hear of your ideas, accomplishments, problems, and solutions. Don't be shy. Talk about it. Maybe some other DSPA Member will be helped or can help you. Even in finding a job!

NEWS FROM MEMBERS

Will Forman--DSPA (23 February '84)
"I just got back from the February luncheon. Brad Mooney was the speaker. His presentation was, in my opinion, the best we've ever had. His topic was the new developments taking place in ocean observations made from space, visual and photographic as well as sensory imagingwith IR, radar, etc. The possibilities seem unlimited. We saw pictures of upwelling currents off the Pacific Coast, seamounts far below the surface, unknown until the shuttle flights, internal waves, and extra long ship wakes. There were 33 in attendance. Brad thought he might get an astronaut to speak to us soon."

Mike Staehle--

"1984 is a year of change for me. I left Perry Offshore where I have been the manager of ROV systems and special government programs these last two years and am in the process of starting my own company to do project engineering, marine engineering, and ocean technology related work here in south Florida. A real need exists and I, with the help of several consulting engineers, hope to fill it. I have also become the south Florida rep for TOOL-TRONICS HYDROSPACE,Inc., with a substantial line of equipment related to our business (Klein, Benthos, Motorola, Raytheon, etc.) which promises to be rewarding and interesting.--I am still in the USNR and was promoted to Captain this past year. I have command of a Mobile Diving and Salvage Unit, MDSU TWO DET 708, in Miami, with a good group pf divers to work with. We will be working on SALVOPS in the old Sub Base, Key West in June.--I see where my old DSV TRIESTE is on the way out in April. I will always count my 4-plus years on TRIESTE as a high point. I know we all will miss her. Perhaps DSPA can find someone to recap her life for the membership.--
My new address, where I live with my new wife Ruth is:

Capt. Mike Staehle, USNR
7013 Edgemere Terrace
Palm Beach Gardens, FL 33410
(305) 626-9413

John Dryfka--Perry Offshore, Inc.
"Thank you for providing me the opportunity to remain a Member of the DSPA. The next time I'm out San Diego way I'll check in advance to see what the meeting schedule is. You might be interested in several of the projects we're involved in. For your records, my home address is:

John E. Dryfka
701-7th Lane
Palm Beach Gardens, FL 33410

Doug McKinney--U.S. Navy (12 March '84)
"I have not been involved in deep submergence since leaving SEA CLIFF. The Navy has kept me busy as ASW Officer on COMCRUDESGRU FIVE Staff in San Diego and ASW Officer on COMCARGRU TWO Staff in Naples, Italy. I am presently assigned to OPNAV-60 in the Pentagon in the Strategy, Plans, and Policy Branch. My new home address:

Cdr. D.L. McKinney
1417 E Wright Circle
Washington, DC 20336

Jack Donnelly--W.H.O.I., ALVIN (24 February '84)
"Perhaps DSPA would like to use some of the enclosed in the Newsltr."

ATLANTIS II and ALVIN are now on Leg III of extended Voyage #112, which will take them from West Palm Beach, Florida, to Tampa, Florida, arriving on March 3. The purpose of this cruise is to study the processes of carbonate periplatform deposition in the open seaways of the northern Bahamas for the University of North Carolina. Four ALVIN dives will be made.

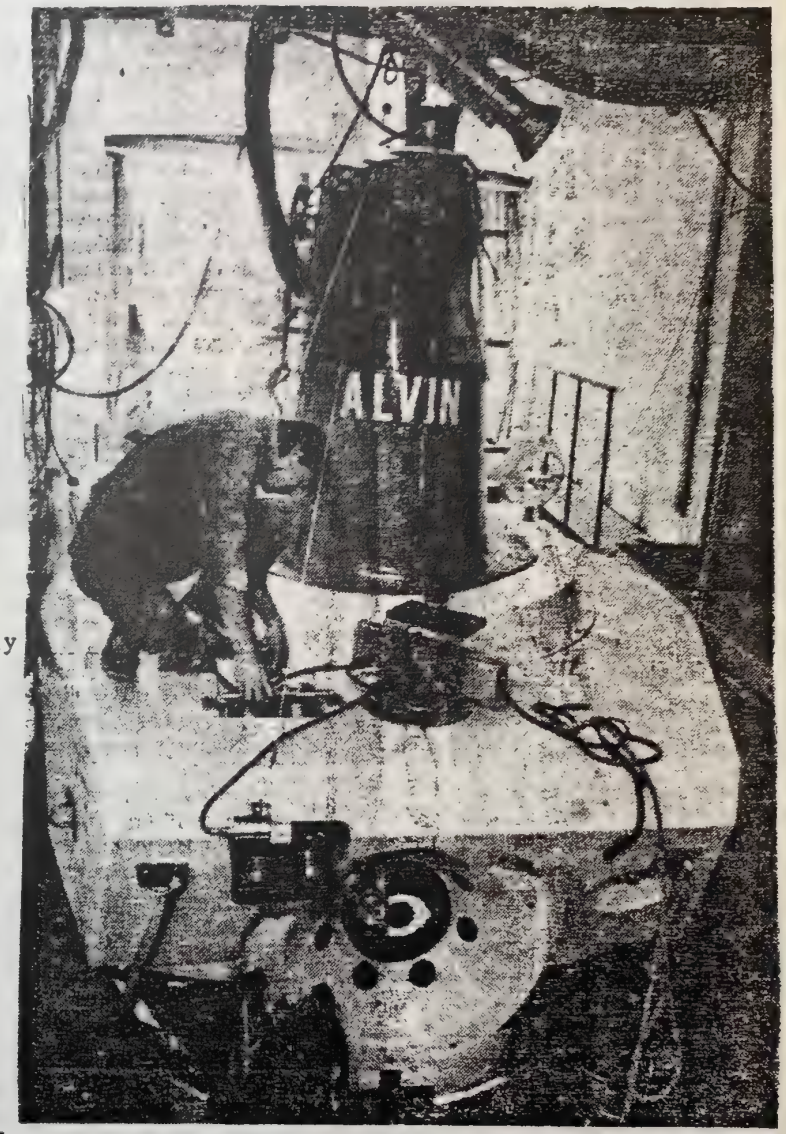
Leg II of the voyage had taken A-II from Charleston, South Carolina, where final adjustments had been made to the ship and the A-frame, to West Palm Beach. Lamont-Doherty Geological Observatory scientists were on board to study abyssal bed forms created by deep-sea currents. ALVIN was used to sample the sedimentary furrows for radio-chemical studies.

A-II is scheduled to transit the Panama Canal in mid-March. She will spend the rest of 1984 along the eastern edge of the Pacific from Mexico to Seattle, Washington, where ALVIN will be used extensively to study ocean bottom geology and vent communities.

Test dives in Charleston and at sea have shown the new ALVIN lift system to be efficient and manageable. Although personnel are not yet allowed to board the sub on the ship's main deck (they must instead be lowered into a small boat and transported to the sub in the water), Barrie Walden, manager of the submersible program, expects the Navy to certify deck loading once the hoist system has been operated and fully tested in the coming months.

A major change to the lift system since it left Woods Hole is the addition of a second line from the A-frame to the sub. During dockside tests, it was found that the sub did not fit properly into the lift harness and angled down at the stern. This imbalance created too much stress on the major lift point and its structural support Rather than cut away more of the sail (and consequently relocate electronics and valves), the design team decided to add a second automatic tension winch on the A-frame to work in conjunction with the main lift winch. A line from the small winch hooks onto the tail of the sub, adding stability during launch and recovery.

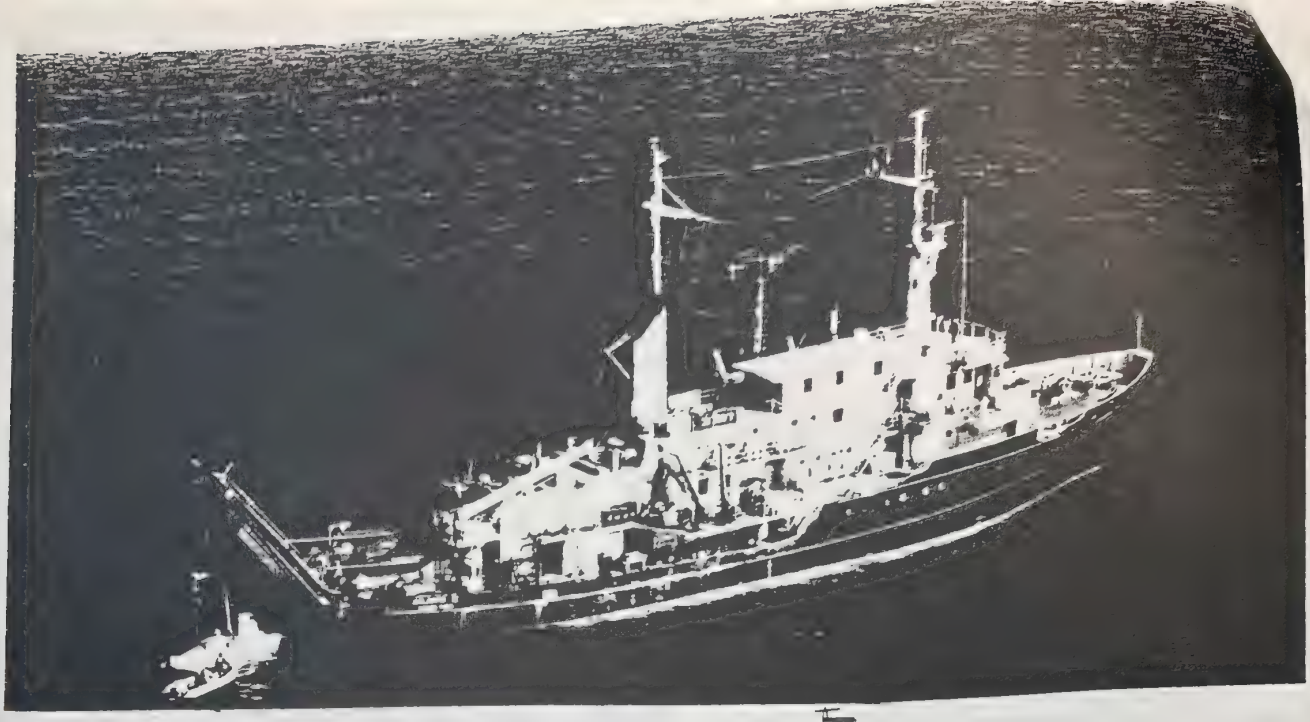
ALVIN is scheduled to make almost 200 dives in 1984; the previous record was 133 in 1982.

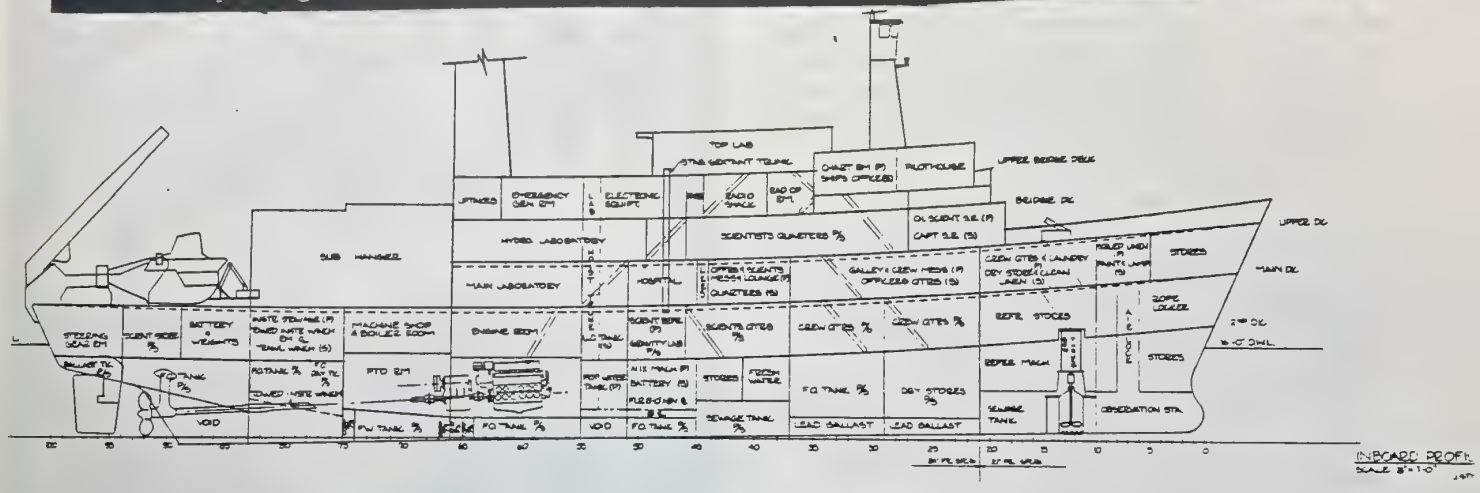


Tribune photos by DAN FAGER

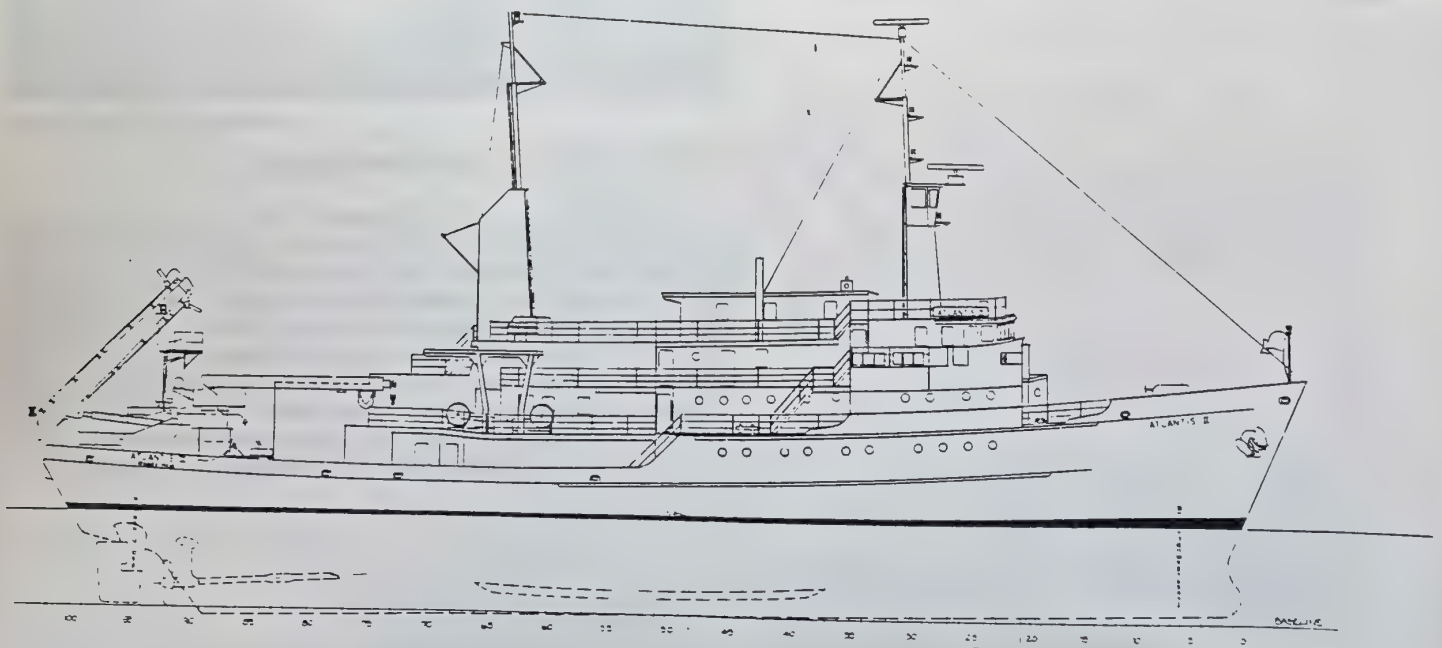
Alvin and his mother(ship)

Jonathan Borden, an electronics technician, right, checks some equipment on the tiny research submarine "Alvin." The sub was aboard its mother ship, the Atlantis II, above, when it arrived in Tampa's port Friday to take on supplies before heading out into the Gulf for another exploratory mission. The 25-foot-long Alvin, carrying a pilot and two scientists, can dive 13,120 feet and chug along at one knot while the scientists peer through portholes and manipulate lights and pincers to study the marine environment. Both science and military research is conducted aboard the sub for the Woods Hole Oceanographic Institution.





INBOARD PROFILE
SCALE 8'-1-0"



OUTBOARD PROFILE
SCALE

Jerry Flaherty--Oceaneering International
"Not a lot is new with me this year. I am still with Oceaneering, Crew Chief of the diving system OCEAN ARMS IV, a tethered manipulator and observation submersible installed on board the MV BLUE DOLPHIN."

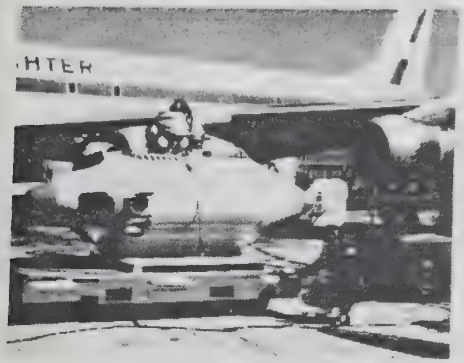
Jerry Shiller--NEKTON, Inc. (15 March '84)
"We are going along fine here at NEKTON. Our big excitement right now is trying to convimce A.B.S. and the ASME-PVHD Committee that, just because they chamged the code on viewports, the NEKTON subs are no less safe than they were before.--I have enclosed for you several items that various people included when they sent in their '84 dues. I'm certain you will find some newsletter material there."

Will Forman--DSPA (3 May '84)
"I received a long letter from the MacKenzies in China. Nothing related to deep submergence was included. Will pass the info along when it is returned from circulation.--Dave Hudacek of DSRV MYSTIC got out of the Navy last week. His replacement , Rick Barnes, said they had nothing to report this month but gave a rain check to report after next month's sea trials.--Our speaker for 19 April was Captain John H. Maurer, Jr., COMSUBDEVGRU ONE. He spoke on the recovery of the F/A18 off of the California coast near El Toro. The aircraft hit the water at an estimated 500 to 600 MPH, so the biggest chunk left was a wheel assembly. Commodore Maurer also showed pictures of the NR-1, of which he had been Engineering Officer. This complemented the previous month's presentation on NR-1 by Commander John Cameron. Seventeen attended the 19 April meeting, including Tim Caffarella's father and grandfather, plus Rick Slater and Larry Shumaker from out of town. John Cameron's presentation on the inspection of NR-1was given on 16 March , only a week or two after he retired from the Navy. He was formerly O-in-C of TURTLE and,, more recently, was on the Navy's Submarine Board of Inspection and Survey Pacific. We had only nine peaple at the March meeting, all Members. --The 137 ft. long NR-1 was launched at Electric Boat in 1969. Usual crew size is eleven. The pressure hull an nuclear power plant make it capable of going to deep submergence for extended periods of time. With any size scientific crew, the living conditions appear Spartan but adequate. --The DSPA meeting on 17 May will be a business meeting with no scheduled speaker.I do wish to urge anyone planning to be in town to attend, occurring, as it does, during the ROV '94 week. It is time to pick a slate of new officers for DSPA. Also, John Schiltz has some suggestions for changes to be considered for the DSPA Constitution, to wit: (1) Increasing the terms of officefrom one to two years and (2) Permitting Associate Members to hold some offices."

Tim Caffarella--NEKTON, Inc. (4 May '84)
"Here at NEKTON, the submersinles have not been very active in 1984, but we do have some work scheduled in the Santa Barbara Channel area in the fall.--Recently, we have received some attention from the news media (article enclosed. Also, one of the local TV stations ran a short news story about NEKTON and NEKTON submersibles. It was rather interesting trying to move around in GAMMA with the cameraman and his camara.....--For your information and that of all other DSPA members, NEKTON has offered for sale the submersible

support vessel M/V SEAHAVEN and the submersibles NEKTON ALPHA and BETA, separately or as a package. If anyone is interested, please have them contact NEKTON Inc. in San Diego at (619) 452-9540."

SUBMERSIBLES / Technical Data



NEKTON submersibles can go virtually anywhere in the world. Light and rugged, they have been transported to remote worksites by ship, train, truck and airplane.

Basic Dimensions

	ALPHA	BETA & GAMMA
Length overall	4.57 m (15 ft)	4.72 m (15 ft 6 in)
Width overall	1.05 m (42 in)	1.05 m (42 in)
Height overall	1.81 m (6 ft)	1.81 m (6ft)
Draft	1.21 m (48 in)	1.14 m (45 in)
Dry weight	2040 kg (4500 lb)	2130 kg (4700 lb)
Pressure hull length	2.28 m (7.5 ft)	2.42 m (8 ft)
Payload	136 kg (300 lb)	204 kg (450 lb)

Performance

Crew	Two: one pilot, one observer
Maximum operational depth	305 m (1000 ft)
Test depth	457 m (1500 ft)
Collapse depth (estimated)	762 m (2500 ft)
Speed, forward and reverse	
normal	3.75 km/hr (2 kt)
maximum	6.5 km/hr (3.5 kt)
Duration at normal speed	3.5 hr
Range	12.9 km (8 mi)
Air Supply	144 man-hours
Turning radius	4.5 m (15 ft)

Equipment

Communications	VHF marine radio; Underwater telephone on 9 KHZ & 27 KHZ
Navigation	Magnetic compass; Directional gyrocompass; Depth gauge; Pinger; Retractable marker buoy; Computerized tracking to 150 m with accuracy of ± 5 m
Search and Recovery	Pinger Location & Tracking on frequencies between 8 & 50 KHZ; Sonar with 182 m (600 ft range)
	Electro-hydraulic Manipulator with 190 cm (72 in) reach, six functions (degrees of movement) & 2500 psi force at 300 m depth External lights, six forward two aft, 150 watts each
Scientific Sampling	Various sampling methods to collect gases, liquids, sediments, fauna and rocks to 12" diam.
Data Recording	Color video tape-recording system; Still 35 mm mono & stereo cameras; Electronic strobe light for color still photography;
Other	External temperature gauge; Current Meter; STDO; Transmissometer

SEAHAVEN

Designed for the deep

The *Seahaven* may be one of the most unusual looking vessels plying the Gulf of Mexico, but she is performing what is becoming a very valuable service in the offshore industry. She is the mother ship for manned submersibles which may be more appropriately called "underwater workboats."

"I like to refer to them as underwater workboats. They're a very useful tool; one that is often overlooked. And, like a tugboat, we have to push things around on the bottom sometimes," said Merle Wilson, vice president of submersible operations for Nekton, Inc., San Diego, California.

Besides "pushing things around," the manned underwater workboats do a lot more than has been widely recognized. Wilson feels that for too long people have thought of submersibles as vehicles for visual inspection and survey and haven't realized the full potential of the workboats.

"Their major use in the past, primarily because people haven't been educated to their potential, has been as observational craft. There are many more things that we can do with manned submersibles than people think of. Recovery is one item. Attachments of guidance lines to fixtures on the bottom is another. Placement of explosives to blow off bent or distorted equipment, using shape charges to reduce or eliminate underwater obstructions—the list goes on and on.

"When people think about what a manned submersible can do in comparison to a diver, they begin to realize the potential and the savings. A divers bounce time on a 300-foot dive is about 10 minutes. That 10 minutes is $1,500 for the diver without even considering the cost of his tenders and the boat that carried him. The Nekton two-man submersible goes for about $2,200 for a 12-hour day. Eight hours of that could well be spent on the bottom doing useful work.

"A lot of the time we're mistakenly thought of as divers. We're not. We're submarine pilots and underwater technicians. In 10 minutes we're in the water. In 15, we are on the bottom working. A diver hasn't even got his suit on in that time. When a rig is down, it's down and not making money. They want results," said Wilson.

As one example of "results," and what a manned submersible can do, Wilson related an experience with a dropped blow-out preventer (BOP) from an offshore drilling rig. The rig was in 650 feet of water and when the BOP fell it did extensive damage on the bottom.

"We recovered the stack, picked up debris, recovered the beacon and the umbilical. The beacon is an acoustical unit which listens for a signal to close the ram and probably costs close to $75,000. The umbilical is probably worth $100,000 or so. The stack is worth more.

"After the recovery operation, we guided the cutters down and onto the original guideposts which are the primary device that guides all working tools onto the well head. We cut off the old guidelines because of the severe damage done when the stack fell on them. Then we took down what is called an 'overshot,' a device that automatically allows them to re-establish their connection. They were then able to re-enter the well.

"Our bill to the oil company was about $30,000. Needless to say, they were awfully pleased with us and what we had accomplished for them," said Wilson.

This feat was accomplished before the *Seahaven* was launched and shows not only the advantage of the manned submersible for bottom work but a cost comparison with divers. During the performance of this job, Nekton had to be lowered into the water by a crane. Union divers had to disconnect and later reconnect the cable. This was done by divers wearing only flippers and snorkels as it amounted to surface work. The bill from the divers came to almost the same amount ($30,000) as that charged by the submersible which had done all of the work.

To accomplish work on the bottom the Nekton submersibles have a ball-bearing type knuckle which permits the operator inside the Nekton

SEAHAVEN

Length	90'
Béam	40'
Depth	7'
Draft (loaded)	3'
Sea Trial Speed	6½ knots
Cruising Range	2,000 miles
Main Engines	(2) Detroit Diesel 6-71
Drive System	Murray Tregurtha right-angle drive
Clutch	Allison
Generator Set	Detroit Diesel 3-71, Delco 30kw
Generator Control Panel	Service Electric
Steering System	Wagner (port), Matthews Autopilot (starboard)
Propellers	Michigan 60/38
Freshwater Pressure System	Jacuzzi
Sanitary System	Red Fox
Mooring Windlass	Palph hydraulic
Elevator Winch	Palph hydraulic
Electronics:	
Radar	Sperry MK-VII
SSB	Decca 150
VHF	Horizon 78
Autopilot	Matthews
Loran C	TI 9000

to operate arms on the outside. There are many different tools which can be fitted and used. Through the sub's glass ports, the two-man crew can also film and/or video tape activity on the bottom.

"A big step is to get people to thinking about a man-operated machine doing the work of a diver. If a job is properly engineered with a submersible in mind, I don't think there is any job which we can't accomplish," said Wilson.

But Wilson doesn't look at any job as being insurmountable. In solving underwater problems with submersibles, Wilson has been in some bizarre places. Possibly the most bizarre was the discharge pipe of a dam. A valve was malfunctioning and divers couldn't solve the problem. Not believing a problem couldn't be solved, Wilson piloted his submersible up the pipe, fixed the valve and returned.

With a cruising radius of 2,000 miles, the *Seahaven* will be able to go on site with her submersibles and solve most problems in short order. The vessel is a new design put together by Wilson and Briant Smith, another one of GOI Nekton's people who doesn't believe there are "insurmountable jobs."

Smith supervised all construction of the mother ship and patiently tolerated the dockside superintendents who asked, "You really think it'll ever fly?"

"We had offers from some of these characters in the beginning who said it would make an awful good 'camp boat' for duck hunting season, but now they look at it and it's a different song," said Smith.

One of the unique features of the ship is the docking ramp which allows the boat to be launched or retrieved in any seas. In the past there were severe operational limitations due to the necessity of using "vessels of convenience"—any vessel that could be hired locally to carry the submersible workboats to the site.

Planned exclusively from the keel up as a handling and support vessel for the underwater workboats, *Seahaven* displaces nearly 200 tons. The mothership is 90 feet long and, because of its 40-foot beam, will provide exceptional stability during launch and retrieval operations. *Seahaven* will be only the third such vessel of this design known to be in operation in the world.

The principle distinguishing feature of *Seahaven* is a rectangular section cut from its stern. This is where the 16-foot long, 4,700 pound Nekton Alpha, Beta and Gamma will motor into docking position under their own power. There is a mechanically-powered elevator which lifts the boat out of the water or lowers it in a launching operation. The elevator is part of the deck and work area when it is in the 'up' position. In the 'down' position it will be submerged about nine feet.

During the docking maneuver the submersible is piloted into position with the aid of a floating, positioning target located to place the sub over a rubber cushioned nesting cradle attached to the elevator. The elevator then lifts the minisub rapidly to the deck level to minimize differential movements between the sub and the ship. Such differential movements, especially in rough seas, can cause severe damage to the sub and pose a safety hazard to operating personnel. It is the ability to launch and retrieve a sub in choppy seas which limits any sub's diving activities. Once launched and below the wave base, it can operate safely and effectively at depth even during a hurricane.

The main advantage of launching and retrieving with an elevator is the elimination of the pendulum effect which occurs when the vehicle is lifted with a cable attached to an 'A' frame or crane.

In rough weather any rolling motion of a support vessel is amplified relative to the length of the boom or cable and a sub launched or retrieved in this fashion could swing wildly.

The cradle, which the sub rides on, rolls on a track that leads into an air conditioned hanger or workshop. The shop is outfitted for complete support of the vessel's mechanical and electronic systems.

Forward of the shop, the living areas include staterooms for a complement of six ship's crew, four submersible crewmen, and a private stateroom for the client's representative. There is also an ample ship's mess, galley and dayroom—complete with a color tv and a video cassette recorder.

Seahaven is based in Morgan City, Louisiana, at this time. Nekton has an office there and another in Houston to service the Gulf of Mexico "Oil Patch".

These tough little submarines, with their pilots and marine technicians, are performing tasks that were only written about in science fiction and adventure thrillers a few years back.

General Oceanographics Inc., Nekton's parent company, has three of the underwater workboats in service. All of the mini-subs will carry a two-man crew. The operational depth is approximately 1,000 feet, but all three have worked at depths from 20 to 70 feet deeper than the limit. The estimated "crush depth" of the hull, the point where the tremendous pressures of depth implode the hull as if it were tinfoil, is approximately 1,500 feet.

Over the last 10 years the three-boat fleet has made over 2,200 dives. The *Nekton Gamma* holds the record for the deepest working dive at 1,070 feet. Although the air supply for the boats is 144 man-hours, the longest dive so far has been for five hours and 50 minutes.

The length of the subs is a little over 15 feet which gives them an instant mobility factor. They can easily be shipped by truck, train, airplane, helicopter or boat to the job site. As Wilson pointed out, when a drilling rig is down the company wants results fast.

"We've had company men for the rigs and engineers argue about this and that and we'd say, 'Well, come on and ride down and you can see what's happening for yourself.' So we'd load up and in a half hour or so the engineer would have made a full visual inspection and could tell exactly what needed to be done to correct the problem. They really are underwater workboats and we get an amazing amount of work done," said Rick Olsen, *Seahaven* pilot.

And as Wilson said, "there's no job they can't perform if the project is engineered with them in mind. And none that I can think of which we can't perform anyhow."

Those words come from a man (and the crew agrees) that doesn't think "insurmountable problems" exist. Some problems are just easier to solve than others.

Geologists take a plunge

By Robert Locke
Tribune Science Editor

The little 16-foot submarine is lowered into the water on an elevator built into the stern of its tender, the Seahaven.

Only its conning tower rises above the murky water, like a yellow trash can, as the sub's battery-powered propeller kicks up a little wake and the craft smoothly disappears, water gurgling into the ballast tanks fore and aft.

Inside, with the radio switched down and the whining engine off, it's very quiet. The two-man submersible rocks gently when an observer shifts position to peer out a 6½-inch porthole.

"When you get some real visibility, it's just like flying," said the Nekton Gamma's pilot, Tim Caffarella. "When you get the tanks trimmed just right, it's like you're a part of the ocean; you're like a fish."

Caffarella talks of the sights he's seen taking the two-man sub down as far as 1,000 feet. But there's not much to see on the bottom of San Diego Harbor: a bit of green algae, a discarded coffeepot, a stray fish or two.

Yet, even so modest a dive is somehow intriguing, with vague hints of the mostly unexploited frontier beneath the oceans.

"You never lose that fascination," said Jay Johnson, senior marine biologist for Nekton Inc. in the Sorrento Valley. "It's always fascinating and exciting to be down there."

Nekton has been seeking its fortune "down there" for three decades, since a handful of young skin-diving geologists launched a moonlighting consulting service to supplement their pay at the old Navy Electronics Laboratory and the Scripps Institution of Oceanography.

Nekton, which sold about $8 million worth of information to the oil industry last year under the enthusiastic direction of it presidents, Carroll Hoyt, just celebrated its 30th anniversary.

And Hoyt talks seriously of someday joining the Fortune 500 list, since this wet frontier offers "a lot of room for growth."

The company, with 110 employees, four ships and three subs, now earns nearly all its income from sophisticated geophysical surveys made from the surface for the offshore oil industry.

But when Nekton incorporated, first calling itself Geological Diving Consultants, it had no employees and the "fleet" was a 16-foot skiff. It chose its officers by flipping a coin and had its headquarters in a garage. But it was taking a whole new approach to undersea geology.

The company began in 1953 as a loose partnership, and "the only reason we dived was for money," recalled Edwin Buffington, 63, who joined the group in 1954. "Diving is not fun, not the way we did it. Diving is nasty, cold, dirty work the way we did it."

He said the partners found their full-time jobs as scientists "very, very satisfying," but the pay left something to be desired.

"So (on weekends and vacations) we took advantage of our particular talents. We were professional divers and we were geologists. There were lots of divers around and lots of geologists, but there weren't very many diving geologists."

Oil companies looking for likely offshore places to drill soon learned the value of having geologists poke around on the sea floor, as other geologists probe dry land. "And we discovered there was a great deal we could do," Buffington said.

Working as deep as 150 feet, the divers not only studied geology, they studied currents and did undersea welding, salvage and blasting up and down the coast.

One important addition in the '60s was seismic profiling, in which sound waves are shot into the sea floor and caught as they bounce back to the surface. Geologists can deduce subsurface geological structures by analyzing the echoes.

The first of three submersibles was built in 1967 because "we figured the subs would be a lot more comfortable way to dive to 150 feet."

The three have logged more than 3,000 dives over much of the world, although demand has tapered off in recent years. Now they mostly do pipeline surveys and surveys required for drilling permits.

By 1974, Buffington said, "the company had money in the bank, but we were still small potatoes."

Then came Hoyt, a petroleum geologist direct from the oil industry. He joined the company, now called Nekton, in 1974 as president and chief executive, and "I recognized that times were changing."

"So we changed what we were doing and we started growing."

Hoyt moved the company full bore into offshore oil exploration with some of the most sophisticated seismic equipment available.

"We're an information company," he said. "We gather information from the oceans."

Nekton doesn't drill wells. It maps the subsurface geology and sells the data to companies that "make their own judgment about where wells should be drilled."

Most of it is "spec surveys — where we go out and acquire the data on our own account without a customer and then make that information available."

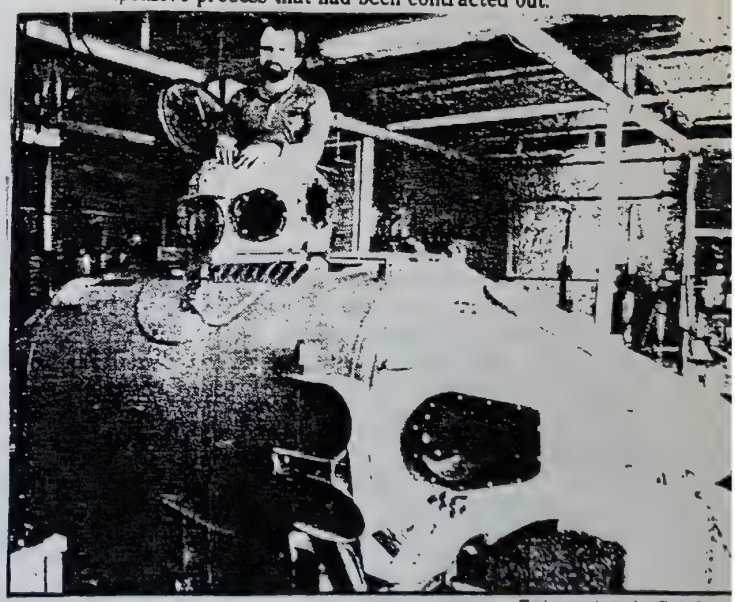
The trick is guessing in which areas the interest will be.

The first full-scale speculative survey was four years ago in the Santa Maria Basin, off the central California coast. The industry now thinks the area has a potentially major oil field, and oil companies have been lining up for drilling permits.

"We were," Hoyt said, "in the right place at the right time."

And Nekton keeps moving. The company just bought a ship designed specifically for seismic work, hoping "it will enable us to get into the overseas market by 1985," Hoyt said.

Nekton is also bringing on line a room full of state-of-the-art computer gear as Hoyt begins his plan to take over most of its own data processing and interpretation — an expensive process that had been contracted out.



Tribune photo by Bob Ivins

TIM CAFFARELLA STANDS IN HIS RESEARCH SUB

Storms in the Abyss... Anything But Tranquil

By Victoria Kaharl
Woods Hole Oceanographic Institution

Victoria Kaharl is a science writer with Woods Hole Oceanographic Institution and a former reporter for United Press International. She holds a master of science degree in journalism/science communications from Boston University.

Fast moving, sediment-laden storms sweep vast areas of the deep ocean on the continental margin off America, causing dramatic changes in the sea floor—scouring it in some places, depositing large amounts of clay and silt in others.

What effect do these benthic storms have on the stability and efficacy of moorings, cables and other objects on the sea floor? Could they affect toxic wastes buried in the deep oceans? Can the apparent flow-related noise generated by benthic storms hamper submarine detection?

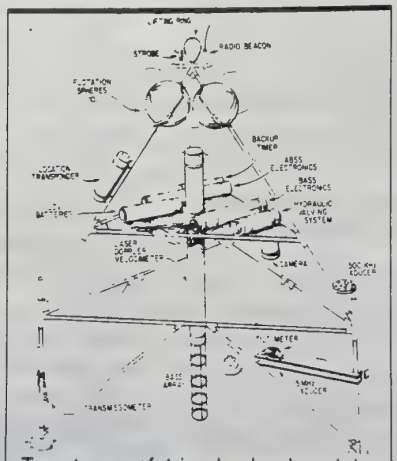
The High Energy Benthic Boundary Layer Experiment (HEBBLE)—sponsored by the Office of Naval Research—is trying to answer those questions and more in an unprecedented close-up look at the abyss.

The research program, which began in 1978 and is scheduled for completion in 1986, has involved as many as three dozen scientists of varying disciplines—from geology to zoology. The results of their work dispel the traditional notion of a tranquil abyss, one of a universal, passive repository for the fine, whirling sediment that for eons has rained down gently from higher up in the water column.

Deep and dark it is, but quiet and calm the abyss is not.

Data gathered so far provides evidence that the dynamical equivalent of atmospheric storms exists deep in the ocean. In a benthic "storm," an eddy or strong flow augments the mean current at the sea floor in water depths of 3 to 5 kilometers, moving water and sediment parallel to the sea floor's contours. The current—moving at over 1 knot—becomes a "storm" when it exceeds the critical entrainment stress on the sediment; i.e., when it lifts bottom sediment.

A benthic storm should not be confused with a turbidity current, which is gravity-driven, always directed down slope and faster moving than a storm by about one order of magnitude. The turbidity current is considered the equivalent of an underwater avalanche, similar to a snow avalanche.



Two types of tripods developed by HEBBLE scientists are designed to free-fall to the abyss, take measurements and photographs for up to 6 months and then be recalled to the surface by acoustic command.

Starting With A Hunch

Charles D. Hollister, senior scientist and dean at the Woods Hole Oceanographic Institution (WHOI) in Massachusetts, was the driving force behind HEBBLE's creation. Long before the HEBBLE team began to measure benthic storms, Hollister believed they had to exist.

As a graduate student at Lamont-Doherty Geological Observatory, Columbia University in New York, Hollister got his first look at a storm-scoured seabed from a 1962 photograph taken by Maurice Ewing of Lamont. The picture, taken at about 4900 meters below sea level in the western Atlantic, depicted longitudinal triangular ripples and dramatic crag and tail markings. At the time, it was generally believed by U.S. scientists that the marks were relic footprints—origin unknown, possibly formed during the last ice age.

Hollister had another theory: he reasoned the bedforms had to be caused by some tremendous—and recent—sediment transporting event.

The need to know drove him in 1964 to take his own pictures. They showed the same type of markings, further confirming his hunch. His photographs, like Ewing's, were taken in the same general area of the western North Atlantic—the area that would become the HEBBLE experimental site.

For the most part, the scientific community adhered to the traditional notion of a peaceful, storm-free abyss: the photographs offered only indirect evidence and weak inferences. As recently as 1978, there was virtually nothing other than the photographs to bolster the theory of a stormy abyssal world, according to Arthur Nowell, associate director of the School of Oceanography at the University of Washington and co-director with Hollister at HEBBLE.

"There wasn't much you could shake a stick at," says HEBBLE's first ONR program manager Tom Pyle, now chief scientist of the National Ocean Service, NOAA. "There were some people who had some deep sea current and sediment transport data, but it was all fragmentary, just clumps and pieces. No one could say these things (storms) existed."

"It was a real gamble," Pyle adds.

The gamble began with mapping the experiment site with Deep Tow—a towed, side-scan sonar system with advanced position-locating hardware developed and run by Fred Spiess at the Scripps Institution of Oceanography. A 2- x 4-kilometer box at a 4820-meter depth about 725 kilometers east of Woods Hole was surveyed to 1-meter resolution.

On an early reconnaissance cruise in 1979 to the site on the Nova Scotian continental rise (40° N, 62° W), the first HEBBLE scientists found what they were looking for. Transmissometers, current meters, and water samples had picked up evidence of unusually high sediment concentrations at abyssal depths in the nepheloid layer.

This layer of water, true to its namesake's origin—*nephos* is the Greek word for cloud—is the region close to the seabed where fine particles remain suspended due to turbulent mixing.

"We found higher concentrations of suspended sediment than we ever expected," recalls Wilf Gardner of Lamont. "A reasonably strong nepheloid layer would yield about 100 micrograms per liter. We were getting up to 12,000 micrograms. It was astounding."

Even more dramatic was the scientists' find a few months later on the second cruise: the instruments had picked up a giant bottom current nearly 5 kilometers below the surface, coursing furiously at more than half a meter a second.

What else they found was enormous temporal variability, ranging from the most severe erosion to tranquil deposition with organism reworking.

Sediment is kept in suspension during a storm. The local mixing level close to the bed increases as does turbulent energy throughout the bottom boundary layer. As a storm wanes, its velocity decreases rapidly, while the level of suspended sediment similarly decreases, causing bedforms and mud blankets to form rapidly.

Nowell likens it to a snow storm: "The benthic storm is very much like a whiteout. The visibility goes to zero. Then when the weather clears, you can see small ripples of mud in striking patterns much like drifts of snow around fences and trees after a real blizzard."

According to the studies of HEBBLE investigator I.N. McCave of the University of East Anglia in Norwich, England, the rapid decrease in suspended sediment concentration implies that all but the finest sediment is settling very quickly, apparently aided by coagulation of particles—much like rain drops growing in a thundercloud.

The stormy current lifts bottom sediment and may transport it as far as 1000 kilometers (perhaps even further) down current. Hollister hypothesizes that virtually all the large sediment drifts in the world's oceans are the result of down-stream deposition of suspended sediment that was lifted from the bottom in stormy areas. Storm-driven sediment resuspension may account for the global distribution of the nepheloid layer, he says.

During a storm, which can last for a few days to a few weeks, the current can carry a ton of sediment per minute, affecting areas tens of kilometers wide. These powerful currents appear to track along certain well-marked paths, but they are not ubiquitous. It is nearly impossible to predict when they will appear. Unlike atmospheric storms, the deep ocean circulation shows no strong seasonal pattern. Long-term current meter measurements indicate the storms are likely to occur every two to three months.

Top map indicates regions of spreading cold bottom water (light stippling) superimposed over large current-controlled accumulations of mud (cross-hatching). Lower map shows areas of highest abyssal sediment concentration.

Benthic Storm: Troublemaker

The storms will increasingly become a critical factor in the design and placement of virtually any ocean bottom object—submarine cables, arrays, anchored or moored systems-meant for abyssal depths in potentially stormy areas. A powerful enough storm may be an invitation for equipment failure. Sediment being transported in a storm from beneath submarine cables, for example, may undercut them and cause strumming. HEBBLE instruments have been "blown away off the bottom," Hollister says. "We have recorded current meter arrays tilted over 30 degrees during storm activity."

"It may not be a coincidence," he

continues, "that the principal problems of the newly laid TAT-7 trans-Atlantic telephone cable from the U.S. to Europe has had most of its trouble in the HEBBLE area."

By virtue of a benthic storm's turbulence, investigators theorize the deep ocean storm must be noisy. But whether the storms have identifiable frequencies or some other type of signature is unknown.

"It's one of many experiments that's crying to be done," Hollister says.

Not least, benthic storms will become an important factor in waste management—especially toxic and radioactive wastes placed on or buried in the deep sea.

"Our results," says the Glasgow-born Nowell, "have important impact on the calculations of dispersal of any material deposited on the seabed. At the moment, there's a worldwide embargo on dumping high-level radioactive wastes, but the Europeans are dumping low-level radioactive wastes and everyone is dumping chemical and pharmaceutical waste. The dispersion of these materials from any site in the deep sea is very poorly understood. The notion of 'containment' of toxic materials on the seabed in a quiescent deep sea is in jeopardy. However, with the high rates of mixing in stormy areas, the dilution of toxic substances to safe levels may be a more appropriate strategy for disposal."

Another HEBBLE investigator, Georges Weatherly of Florida State University, has gathered evidence linking the storms to the Gulf Stream's warm core surface eddies. If Weatherly's results can be generalized, maps made from *Seasat* satellites of high sea surface topographic variability can be used to identify other regions of the world's oceans likely to experience benthic storms. For this generalization to be true, however, two factors must be present together: a strong mean flow and a maximum of sea surface variability.

If the coupling is accurate, Hollister speculates, it means benthic storms affect vast oceanic areas of vital strategic importance. Those areas include the entire northern part of the North American Basin, the entire Argentine Basin, vast areas south and southeast of the southern tip of Africa, the region surrounding the Kerguelen Plateau, the Bellingshausen Sea and the area south and east of New Zealand.

On an early reconnaissance cruise to this HEBBLE area on the Nova Scotia continental rise, scientists found unusually high sediment concentrations in the nepheloid layer.

Swedes hunt for sub: 'Something is there'

KARLSKRONA, Sweden (UPI) — Swedish navy ships detected more traces of an underwater intruder near a sensitive naval base yesterday, and officials, convinced they have cornered a foreign submarine, put land forces on full alert.

"There are so many indications that something is here," said Lt. Col. Evert Dahlen of the Swedish defense staff, "but we don't know ... what."

"We assume it is a foreign minisubmarine or something similar," another government spokesman said.

The intruder was first detected about two weeks ago in the waters near the sensitive Karlskrona naval base outside the Baltic city of 60,000, about 180 miles south of Stockholm.

The navy dropped 22 depth charges during the days of searching to force the foreign vehicle to the surface and Friday, for the first time in the search, detonated a mine in the water.

The mine was exploded between two islands guarding the main approach to the base. Naval spokesmen said the detonation followed "a minor indication on an underwater magnetic warning loop," an underwater tracking device.

The navy's experts spent yesterday studying the effects of the explosion and checking numerous reports of periscope sightings.

Sweden has repeatedly warned it will destroy intruders in its waters.

The search was taking place less than five miles from the narrow bay where a Soviet submarine ran aground in October 1981, causing a chill in Swedish-Soviet relations that still remains.

Searchlights at the Kungsholms fort Friday night swept over the 20-square-mile area inside a string of islands barring the entry to Karlskrona, while several Swedish signal flares lit up the sky.

Armed soldiers were placed on high alert on the islands. A defense spokesman would not rule out the prospect of a firefight if the submarine is abandoned and its crew attempts an overland escape.

Local defense forces are also on full alert, and "we exclude nothing," he said, adding that security police suspect foreign agents on land may be aiding the intruder in the shallow waters.

Reports in Swedish newspapers speculate that a "mother" submarine may be directing small, unmanned underwater vessels in the Karlskrona basin.

Submariners get break

SAN DIEGO UNION 19 FEB 84

By Ed Jahn
Staff Writer

The 50-foot-long, olive drab cylinder fastened to the deck of a nuclear submarine at first looks like some exotic weapon ready to erupt in flames and blast its way to the enemy.

The mission of this strange craft, though, is one of lifesaving rather than destruction. For submariners stranded on the ocean floor in a stricken vessel, it is their primary chance of rescue.

The Navy calls it a deep submergence rescue vehicle (DSRV) and it is aptly named Mystic.

The Navy developed Mystic after it lost two submarines and more than 225 sailors in two incidents on the ocean floor in the 1960s.

"Fortunately, we have never had to use Mystic," said Lt. David Hudacek, officer in charge of the odd craft. "So we train and train for something that we hope will never happen."

Only two of these curious vessels exist in the world and both are stationed here at the North Island Naval Air Station. Yesterday, the Mystic was loaded on the submarine Gurnard at the Submarine Base in Point Loma for a week of training exercises off La Jolla.

Hudacek said piloting the Mystic is a lot like flying an airplane except that top speed for the 36-ton, battery-powered Mystic is a bit less than four knots.

What Mystic lacks in speed, it makes up for in precision and maneuverability with thrusters and a large propeller that can make it perform at angles up to 45 degrees.

"Imagine sitting in the cockpit of an airplane surrounded by instruments and that's what you have with the Mystic," Hudacek said as he directed loading of the craft onto the Gurnard yesterday.

View ports, several sonar systems and a series of video cameras assist Hudacek in maneuvering.

"There's a navigational system identical to the one used in the lunar lander. But where it read "moon" on the lunar lander, our's reads 'ocean,'" he said.

Although capable of deploying anywhere in the world, Mystic and its sister ship, Avalon, can only go down as far as 5,000 feet.

Unfortunately, the Mystic would not have been able to assist in the last two major submarine tragedies.

In April, 1963, the nuclear submarine Thresher, with 129 crew members aboard, was lost in the North Atlantic. In May 1968, the nuclear submarine Scorpion with a crew of 99 went down near the Azores.

In both instances, the submarines went down in great depths and there was not time to perform rescue operations.

The concern over those two submarine losses, however, added to the initiative to develop a rescue source and in 1970, DSRV-1 was launched here and christened Mystic. The craft was accepted into the fleet in 1978.

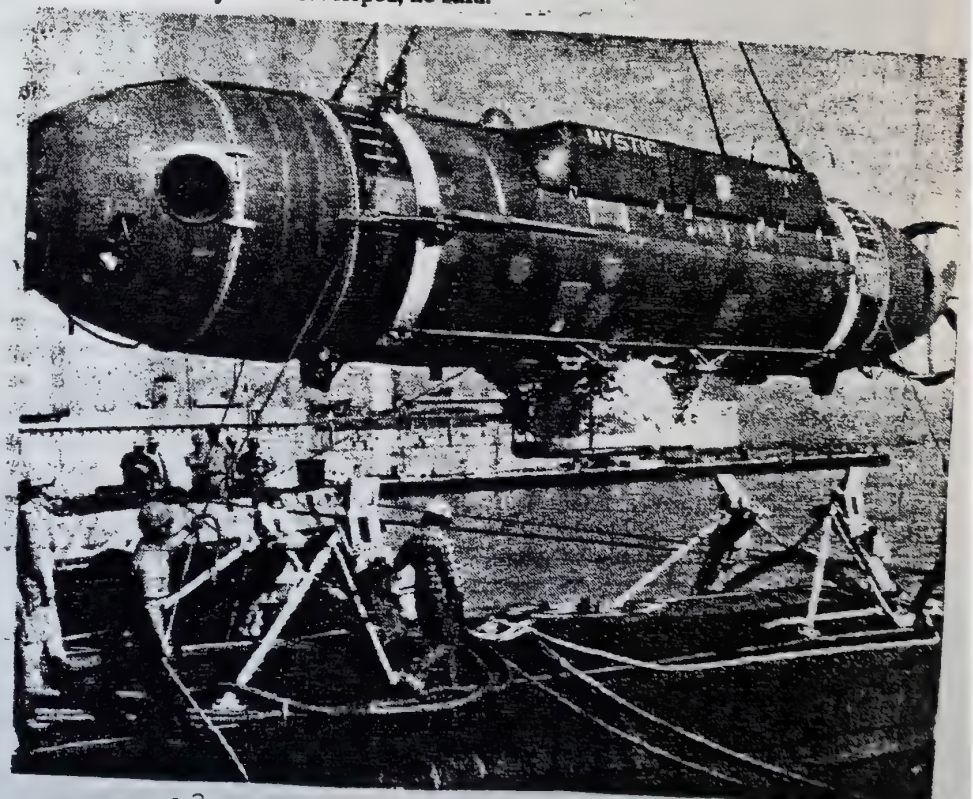
According to Hudacek, a "scenario" involving Mystic would start with a distress call to the 18-member crew, which is on a four-hour alert. Mystic, along with a carrying apparatus, would be loaded on a transport aircraft and flown to the port nearest the submarine in distress, he said.

Mystic would then be loaded "piggy back" on the deck of a submarine and taken to the emergency site or it could be shipped to the scene on a special boat, depending on the situation, he said.

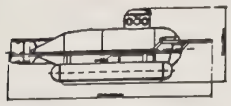
Mystic's hatches are compatible with all the Navy's submarines and the rescue craft would attempt a successful "mating" with the disabled sub's hatch.

Then it would begin taking 24-passenger loads from the stricken submarine to safety until all of the approximately 140 crew members are recovered, Hudacek said.

Training for the DSRV alone takes about nine months and there have been less than 100 officers qualified to run a DSRV since they were developed, he said.



DISCOVERY BAY MARINE LABORATORY



PC 8
OBSERVATION SUBMERSIBLE

SPECIFICATIONS

GENERAL DATA

CONSTRUCTION

SYSTEMS

STANDARD EQUIPMENT

SAFETY FEATURES

DISCOVERY BAY RESEARCH SUBMARINE PROGRAMME

The Discovery Bay Marine Laboratory is offering a unique opportunity to participate in a scientific mission in our research submarine Perry PC8-B.

One entire day of your visit to the Marine Laboratory will dedicated to learning about the submarine and actually serving as a crew member on a dive. Each person will receive at least two hours of submarine dive time.

PC8-B is a very sophisticated deep diving observation submarine. She was built to ABS (American Bureau of Shipping) Manned Submersible Standards by Perry Submarine Builders in 1971, and since has logged over 800 dives. PC8-B is capable of carrying a pilot and two crew members safely to a depth of 800 feet.

Submarine missions will take place most days of the week - weather variations are not a major consideration as we will be under the waves! The majority of the missions will be to a depth of 600-800 feet, with the crew experiencing a wide range of depths during any dive.

Our missions day begins at 8:00 AM. The programme calls for all sub crew to have a brief tour of the facilities at the Discovery Bay Marine Laboratory and then adjourn to a classroom for a slide presentation on the geologic formations of the coral reefs along Jamaica's north coast and the marine life zone will encounter while exploring these reefs. This will be followed by a lecture on the operation of PC8: its multiple safety and communication systems, manipulator arm and some of the photographic apparatus. After the lecture, crew members will be issued a set of cotton overalls and their personal life-support equipment.

The first dive will be at 9:30 AM. The pilot and two crew will - check the submarine out - lock in -be lowered into the water - and towed to the dive site (just outside the reef). The tow boat will release the sub on command, and PC8 will submerge to 30 feet for a "bubble check". The other participants are welcome to ride along in the tow boat to watch the descent of the sub. After the underwater communications have been checked, PC8 will request "Permission to dive". On that command, she will leave 30' and cruise under calm water power to the 150' level where the underwater cliffs begin. After gently gliding down the face of the reef, the observation lights will be illuminated around the 250' mark and the cabin lights dimmed. All three occupants will have a feeling of sharing an incredible, once in a lifetime learning experience as they descend still deeper down the face of the deep-fore reef.

The submarine will be engaged in the aquisition of photogrammetric and oceanographic data on each mission. Crew members will be expected to assist in the pre-planned mission activities. All aspects of the dive will be recorded in the pilot's log and a copy of which will be available to the crew members who participated on the dive.

Crew changes are made approximately every 2 hours and will be done as quickly as possible to allow everyone the maximum amount of dive time. A total of six participants may dive per day, although we prefer four (with the average dive and change-over lasting 2½ hours, a full 8 hours would be consumed if we have six participants). Children over eight are welcome.

CANDIDATES FOR SUBMARINE RESEARCH DIVE MISSIONS

All participants must be agile enough to climb into the conning tower entry hatch and crawl to their assigned positions in the submarine. Persons who are not comfortable in close and confined areas are advised not to participate in these missions.

Each crew member will be involved in an actual scientific mission and will be expected to:

1. operate accessory equipment
2. communicate with the surface chase boat
3. report and record observations
4. actuate camera and strobe systems etc.

The crew members will change stations during the dive missions so that each member may have his or her turn at operating the systems and observing next to the hemispherical forward viewport. Furthermore, everyone will be trained in the operation of the many safety systems prior to their dive.

SUBMARINE CREW CHECKLIST

1. Eat a light breakfast before the dive.
2. Please do not wear heavy perfumes or aftershave.
3. Bring at least two dry swimsuits and two towels per person.
4. You may bring gum, snack bars, fruit and canned soft-drinks in the sub. We will provide water and emergency rations.
5. Please ask us for an oral or dermal motion sickness tablet - this is important for everyone!
6. You may not take any smoking materials into any classroom, restroom, boat or submarine. Smokers should plan to do without for at least four hours.
7. Submarine crew members will be provided with fresh cotton overalls to wear over their dry swimsuits. Sweat shirts and sweaters will not be necessary during the dive.
8. You may wear dry clean socks or bare feet in the submarine - no shoes.
9. You may bring a camera (strobes or flashes are not necessary) and take as many photos above and below as you wish. Our external photo lamps can be used to light your subjects at depth.
10. Each crew member must be weighed prior to the dive (along with your camera and snack items).
11. You may bring snorkel gear (including a BC) to watch the sub's descent or to relax while others are in the submarine.
12. Showers and restrooms are available on shore at the submarine base.

Each dive participant will receive : a crew T-shirt
a copy of the dive log and mission checklist
a shot of the sub and their crewmates

Copies of the underwater photos may be purchased separately.

RATE SCHEDULE - PC8-B SUBMERSIBLE

PC8-B is an observation submersible which is equipped to carry two researchers and a pilot to a depth of 800 feet.

The rates quoted below include the use of the submarine, pilot, chase/tow boat and manipulator. NOTE - Two hour minimum per dive.

RATES

RATE PER TWO HOUR DIVE - PER PERSON	$ 175.00
RATE PER SIX HOUR DAY	900.00
RATE PER FIVE DAY WEEK	$000.00

(DAY RATES ASSUME ONE SUBMERSION AND ONE SURFACING - A SURCHARGE OF $50.00 WILL BE MADE FOR EACH ADDITIONAL SURFACING)

EXTRAS: CAMERA - VIDEO - ONBOARD RECORDERS

EXTERNALLY MOUNTED PAR AND TILT CAMERA UNIT RATES ARE AS FOLLOWS

36 ROLL EXPOSURE ROLL WITH STROBES	$ 30.00
100 FOOT ROLL OF BULK LOAD FILM (INVESTIGATOR TO SUPPLY FILM)	50.00
ONBOARD CASSETTE RECORDERS (INVESTIGATOR TO SUPPLY CASSETTES)	15.00

*ALL PRICES ARE QUOTED IN US DOLLARS

**CHEQUES SHOULD BE MADE PAYABLE TO: DISCOVERY BAY RESEARCH FOUNDATION
7557 RAMBLER ROAD
SUITE 624
DALLAS, TX 75231
ATTENTION: MR. STEPHEN POTES

Discovery Bay Foundation To Lease Three-Man Sub

The Discovery Bay (Jamaica) Research Foundation recently signed a three-year lease with Research Submersibles Ltd. of Grand Cayman, British West Indies, for the use of a Perry PC8-B submersible.

The PC8-B, a three-man observation, 224-m A.B.S classified submersible, will be operated from the University of West Indies' marine laboratory in Discovery Bay. Among the distinguishing features on the PC8-B are a manipulator, cameras and a 36-inch hemispherical forward viewpoint. The sub will be made available to marine researchers, student groups and visitors.

Will be pleased to carry covers on all of our missions.
With the compliments of
Phillip Jones Diving Officer Chief Pilot
UNIVERSITY OF THE WEST INDIES
DISCOVERY BAY MARINE LABORATORY
P.O. BOX 35, DISCOVERY BAY, ST. ANN, JAMAICA, WEST INDIES
TEL. (809) 973-2241

Survey Ship Finds 12 Bodies Of Sunken Oil Vessel's Crew

HOUSTON—Global Marine Inc. said a survey ship working off the coast of China found the bodies of 12 crewmen from the Glomar Java Sea, an oil drilling ship that sank with 81 crewmen aboard in October. No survivors have been found.

Global Marine said the bodies will be taken to Hong Kong for identification in about a week, once the survey ship completes its investigation of the sunken wreckage. The 5,930-ton Glomar Java Sea was operating in waters about 60 miles south of Hainan Island in the South China Sea when it disappeared during a typhoon Oct. 25.

Thanks to Charles Simpson for the list below.

THOUGHT THAT IT MIGHT BE OF INTEREST TO HAVE A COUPLE OF SUMMARIES OF REFERENCE.

The first is a listing of where 'ex' submersibles can be viewed:

NEMO-San Diego,Ca.(Naval Ocean Systems Center)
DEEP-DIVER-Ft.Pierce,FL(Planet Ocean)

BEAVER MOCKUP VEHICLE-Houston,TX(Herman Park Museum)
KUMUKAHI-Waimanalo,HI(Sea Life Park)
DEEP VIEW-Bay St.Louis,MS(NOAA NASA/NSTL Naval Ocean Research & Devel. Activity Sta.)

STAR I-Philadelphia,PA(Maritime Museum)
SEALAB I-Panama City,FL(Naval Coastal Systems Laboratory)
TRIESTE I FLOAT-Washington,DC(Naval Yard)
DEEP SIX-Miami,FL(Playground Display)
CUBMARINE PC3B-Huntsville,AL(Alabama Space & Rocket Center)

And the second is a cross-reference on name changes by all the assorted submersibles through the years:

ALVIN(6000')-ALVIN(6000' rebuilt)-Alvin(12000')
AMERSUB-SPORTSMAN 300-TIBURON MARINE LAB SUB-U.R.V.
ASHERAH-STAR II-ASHERAH
AUTEC I-SEA CLIFF(DSV-4)(6500')-SEA CLIFF(20000')
AUTEC II-TURTLE(DSV-3)
DDS CONSTRUCTOR(sub)-ANL(bell)
DSRV 1-MYSTIC
DSRV 2-AVALON
DSV 5-NEMO
K250-VAST MK III
K350-SUSIE
LIMA 5-L5-LRV-LEO V
PAULO I-SEA OTTER
PC3B-TECHDIVER
PC3X-SUBROSA-GASPERGOU
PC9C-SURVEY SUB I-TS1-PENSUB 9
PC5C-NAI'A-ANDRY(P-82)
PLC-4-DEEP DIVER
PC14-DIAPHUS
PC15-VOL LI-LI
PC15D-LII-L2-LIMA 2-LRII
PC15L-LIII-L3-LIMA 3-LR3
PC15-LIV
PLC-4R-SHELF DIVER
PX8-AUGUSTE PICCARD
PX15-BEN FRANKLIN
PS2-TUDLIK
ROUGHNECK-BEAVER-BEAVER MKIV
SP300-DIVING SAUCER(La Soupcoupe Plongeante)-DENISE-DS2-SP350
SP500-SEA FLEAS(Puce De Mer)
SP3000-CYANA
STAR II-MAKALI'I
TRIESTE I(40000')-TRIESTE II(20000)
SWD101-SEA RAY
HYDROLAB-NULS 1
X150-SUB BUG
MINNOW 3-PENSUB 3
MINNOW 4-PENSUB 4
LRV-PENSUB 1
note:ALVIN is also DSV-2
MANTIS 007-MARNET

ANY ADDITIONS,CHANGES,OR COMMENTS WOULD BE MOST APPRECIATED!

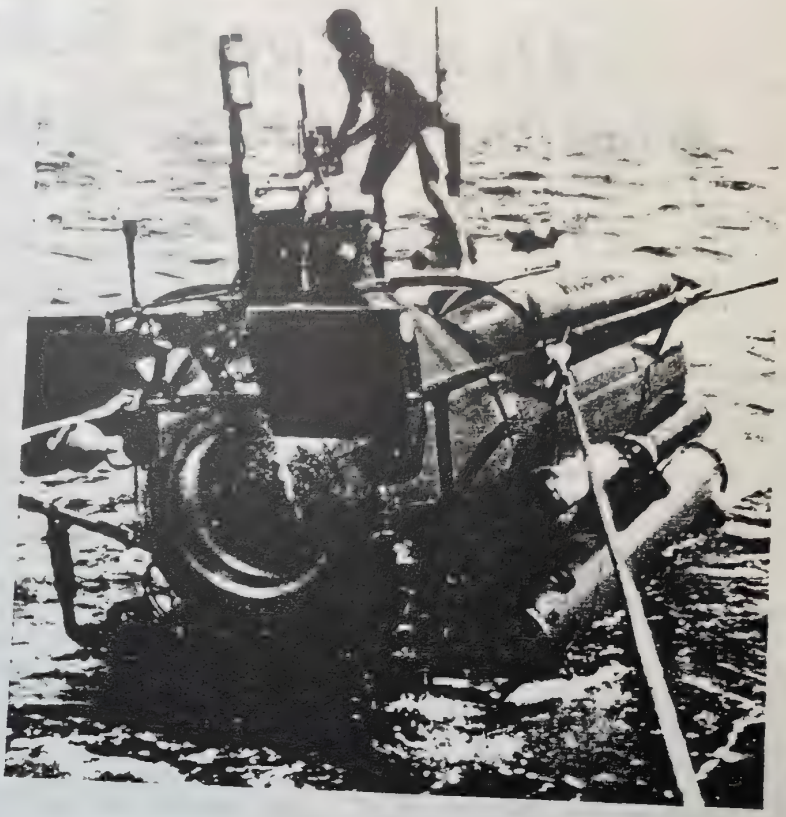
PERRY
PC-16
SUBMERSIBLE

A 4-Man Subsea Vehicle designed for

- **Dry Transfers**
- **Site Surveys**
- **Manipulator/ Maintenance Tasks**

to depths of 3000 FSW

(Optional designs to 5000 FSW)

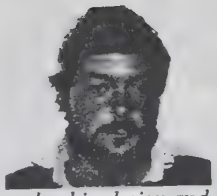


- **Pilot/observation compartment features large hemi viewport, human-engineered controls**
- **Modular dry-transfer and propulsion compartments provide space for equipment storage**
- **Independent port and starboard battery pods and redundant life-support systems for missions up to 8 hours plus 7-day emergency support**
- **Crane Weight: 17 tons • Speed: 2.0 knots**
- **Typical bottom time: 8 hours**
- **Options include: Advanced On-Board Manipulators — Bottom Survey Equipment Sonars — Underwater-Mateable Hydraulics Short and Long-Baseline Navigation Equipment**

PERRY OCEANOGRAPHICS, INC.

Deep Rover Submersible Features Force, Touch Feedback

John Bouvier
Manager, Manned Submersible Division
Deep Ocean Engineering, Inc.

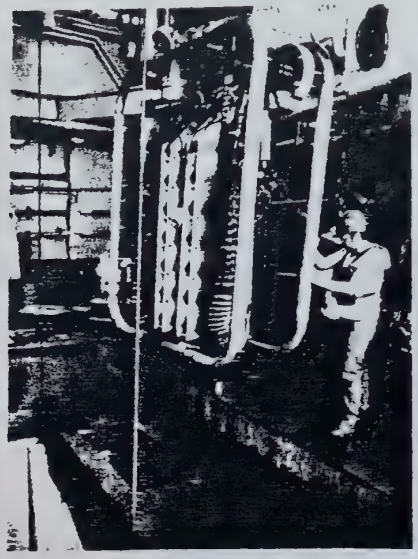


John Bouvier is projects manager for the manned submersible division of Deep Ocean Engineering, Inc. For the past several years, Bouvier has been involved in design and production of the Bandit *RCV. He currently is managing the* Deep Rover *project. Bouvier was educated in Europe, living extensively in France, Germany and Spain. He has worked as a commercial diver and supervisor on several projects in the Gulf of Mexico and the Pacific northwest.*

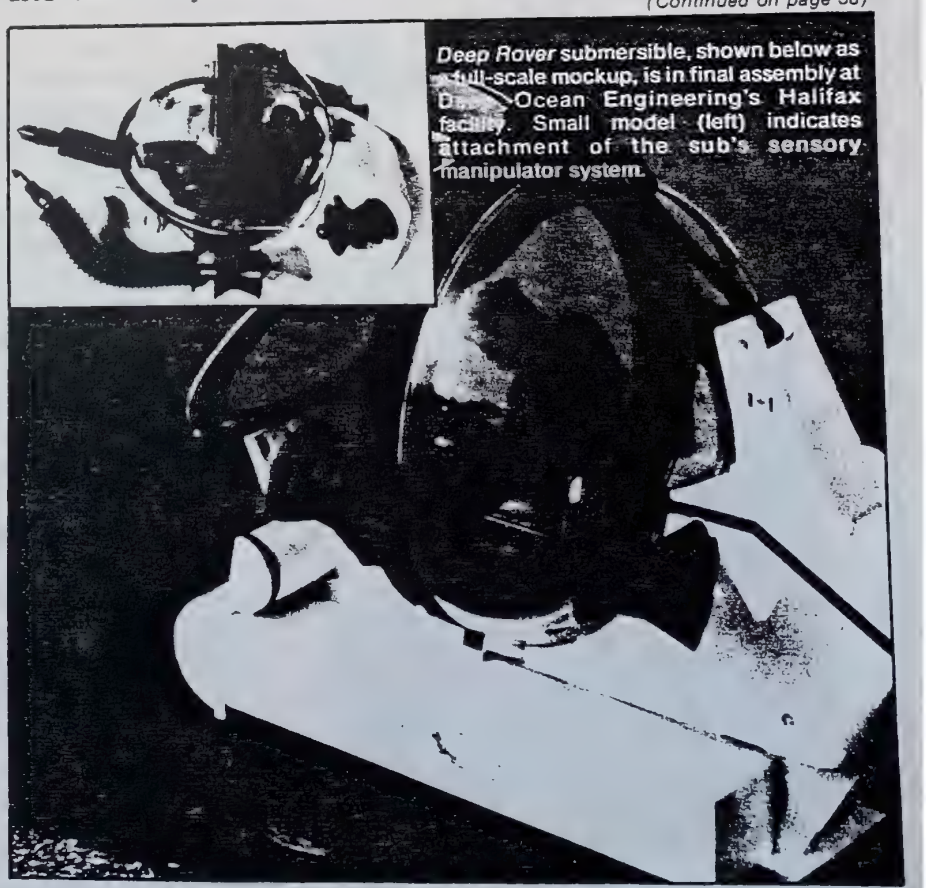
Founded in 1981, Deep Ocean Engineering and its sister company, Deep Ocean Technology, have developed an impressive record of accomplishments in just a few short years of operation. With offices located in Oakland, California; Halifax, Nova Scotia; and Houston, Texas, these two companies have grown rapidly to meet the demands of offshore operations while, at the same time, maintaining an ongoing research and development program. Spearheaded by Graham Hawkes and Dr. Sylvia Earle, these two companies have quickly launched into the development of several new and unique subsea designs.

Hawkes, designer of the widely used one-man systems, *Wasp* and *Mantis*, has in conjunction with his engineering staff recently developed two new underwater vehicles. One is a robotic device, *Rig Rover* (better known as *Bandit* because of its one-arm manipulator), dedicated for use on offshore oil rigs. The other, *Deep Rover*, is a general purpose one-man one-atmosphere microsubmersible. Both are equipped with Deep Ocean Engineering's sensory manipulator system that features a unique modular construction and feedback systems that include force, motion,

(Continued on page 38)



Deep Ocean Technology's *Rig Rover* heads for another task at 365 meters.



Deep Rover submersible, shown below as full-scale mockup, is in final assembly at Deep Ocean Engineering's Halifax facility. Small model (left) indicates attachment of the sub's sensory manipulator system.

(Continued from page 37)

and touch. Deep Ocean Engineering is primarily devoted to the design and development of *Deep Rover* and manipulator technology while Deep Ocean Technology acts as an operating company for the *Bandit* systems.

The *Bandit* vehicles represent a new concept in offshore oil and gas explorations and production support. These systems are remote controlled, guide-wire deployed vehicles that ride on any guide line or can be deployed as a free-swimming ROV to deliver two sensory manipulators to the job site. Currently working on the Zapata *Saratoga* rig for Shell Oil, *Bandit* has proven to be a workhorse in demonstration of the design goals. Operating for more than 7 months in 245 to 365 meters of water in the Gulf of Mexico, *Bandit* has had an average operation of more than 600 hours per month performing the work of a well-head TV as well as tasks including AX ring removal, guideline cutting and replacement and re-establishing hydraulic connections to cleaning the rig's levelling devices and assisting in replacing the control pods. *Bandit's* superior camera system is used almost exclusively for monitoring drilling operations. A specially developed overview camera mounted on a pan-and-tilt unit operates in conjunction with wrist mounted cameras to give an unusually well balanced view of operations.

The operator in a control van on the rig guides the system, performs and documents the work and maintains the system. Typically *Bandit* stays underwater continuously for five to six days, on call at a moment's notice. After a few hours of routine maintenance, the system is again ready to resume operations.

First *Deep Rover* Assigned

The first *Deep Rover* system is currently being built for Can Dive Services, Inc. of Vancouver, British Columbia, and is scheduled for completion this month. It is being assembled at a joint Can Dive Deep Ocean Engineering facility in Halifax, Nova Scotia, and has been contracted to Petro Canada for work in eastern Canadian waters.

Deep Rover is being built to Lloyd's standards with a depth rating of 1000 meters. The system has panoramic viewing through a 13-centimeter-thick, 1.5-meter-diameter acrylic pressure hull, a maximum speed of 3.2 knots and carries life support for approximately seven days.

Unlike most other manned systems, *Deep Rover* has the option of being deployed with or without a tether depending on the particular job or conditions. The system is completely autonomous. The low weight (3085 kilograms) makes it possible to transport and launch *Deep Rover* with much greater ease than is possible with conventional two-or three-man submersibles.

Variations of the system are now under development. One is a two-man version that can, in it's first stage, take an operator and passenger to 500 meters in a 8-centimeter-thick acrylic pressure hull; otherwise, the characteristics and appearance are similar to the present 1000-meter *Deep Rover*. Deeper versions of both the one- and two-man systems will be produced in the near future that are intended to provide safe, cost-effective working access to full ocean depths.

The manipulator systems used on *Rig Rover* and *Deep Rover* are regarded by its designers as the most significant breakthrough in achieving improved capability in an environment hampered by extremes of pressure, temperature, and corrosion, whether used on remotely operated vehicles or manned systems. The sensory manipulator system is constructed of graphite-loaded reinforced plastic, aluminum, and stainless steel, a combination of materials application innovated with the *Mantis* in 1978. Several aspects of the new manipulators are particularly significant from a practical view point. The modular construction makes it possible to begin with a basic three-function system, then add functions as required. For special jobs requiring a longer, shorter, or unusually configured system sections can be added or taken out within minutes.

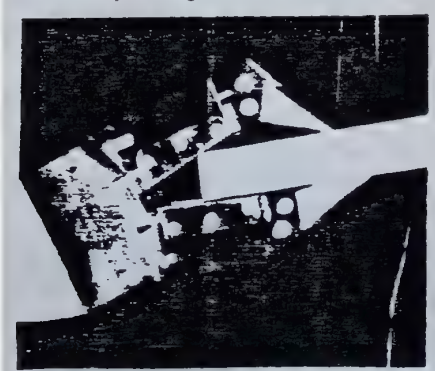
Thinking Man's Manipulator

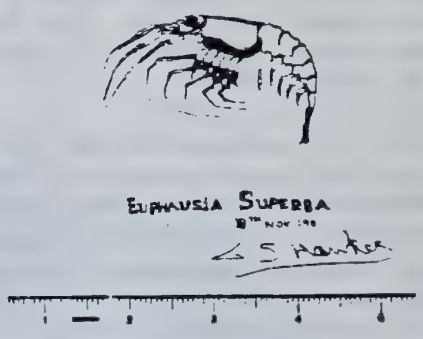
Unlike most manipulators currently in use subsea, neither push buttons nor joy stick control need be employed. Rather, the operator grasps a controller that is, in some ways, comparable to the controller in modern fighter aircraft. An instinctive mode of operations is possible, wherein the operator "instructs" the manipulator with minute force inputs and virtually "thinks" the desired action in order to achieve the work required.

The basic simplicity of the system, ease of operation and low maintenance are features that are important in establishing day-in day-out reliability. Such has been achieved with the manipulator where, to date, essentially no maintenance has been required on the manipulators since they were put into nearly continuous subsea operation in June 1983.

The sensory systems include force and motion, but the tactile sense coupled with precision of movement that can be measured in thousandths of inches provides the sensory manipulator system with its most unusual capability. Human hands are expected to perform a wide range of tasks from the broadest movement to the finest control. The design

(Continued on page 39)





Series of photos demonstrate the *Deep Rover* sensory manipulator system's dexterity, delicacy of movement and precision. Drawing of shrimp was made by designer Hawkes with 2-meter-long unit.

objective with the sensory manipulator system was not to precisely duplicate the human arm but rather to develop a manipulator that could allow an operator to perform work under a variety of conditions in a hostile environment while he remains safe on the surface or within a protective vessel. In some ways these manipulators exceed the capability of the human arm. Each arm on the *Deep Rover* and *Bandit* systems is capable of lifting 90 kilograms, and a small system (half-scale) can lift in excess of 45 kilograms. Torque at the wrist is approximately 100 foot pounds. Additionally, in conjunction with precise control, the operator can distinguish differences in texture and composition of materials even when blindfolded.

At present, the capabilities of the sensory manipulator are not being utilized to their fullest extent, perhaps in part because the work usually expected of underwater vehicles and manipulator systems has not taken into account the precise, dexterous systems that provide an operator with a sense of touch, whether sitting in a pressure hull or located hundreds of meters away in a control van. As the capabilities are recognized, it is likely that more difficult and challenging tasks will be expected of this and subsequent sensory manipulator systems that are now in the design phase.

On Reflection

Never in all the known history of man has there been a generation such as ours ready to use the great mass of accumulated technology to explore the ocean depths. A universe awaits us with treasures as varied as our collective imaginations. From the primitive diving bells of the third and fourth centuries B.C. to the more sophisticated systems of today, man's quest of the oceans has really only just begun. It is not enough simply to have the capability, we must give quality to our exploration of the oceans.

Aberdeen Companies Set North Sea Recovery Mark

Two companies have established what is believed to be a record for the North Sea diving industry by recovering a dropped blowout preventor (BOP) and associated debris weighing over 275 tons from the 5500-meter deep Troll field off the Norwegian coast.

Wilhelmsen Offshore Services and Wharton Williams Taylor, both of Aberdeen, Scotland, placed a nine-man team using a "Spider" atmospheric diving system aboard the submersible *Treasure Saga*. The operation was carried out on behalf of Saga Petroleum.

In all, the crew conducted 18 dives that lasted a total of 77 hours. Equipment recovered from the field included the BOP stack, which was two-thirds buried in the bottom, 11 joints of marine riser and the slip joint.

The diving system was loaded on a supply vessel at Aberdeen by Wharton Williams Taylor and was at the scene of the accident within 48 hours of the initial request by Saga.

S & H Diving Acquired By Sonat Subsea Services

Jack Smith, chairman of the board of S & H Diving Corporation, Inc., has announced the company's acquisition by Sonat Subsea Services, Inc., a subsidiary of Sonat, Inc. of Birmingham, Ala. All officers and management of S & H will remain with the company and continue to direct its activities.

Operations will be conducted as S & H Diving Corporation, a subsidiary of Sonat Subsea Services. Operations offices for S & H will remain in Morgan City, La., and corporate offices will remain in Houston but will relocate to the Sonat Tower, 5599 San Felipe #1317, where Sonat Subsea is headquartered.

Navy Has Two Ocean Diving Capability Under Saturation

Ever since it was proved in the early 1970s that operational saturation dives were possible to a depth of 260 meters (850 feet) the U.S. Navy's plans were to achieve that goal.

Just proving that the dives were feasible wasn't enough, however. It meant planning for developing operational equipment, providing training facilities and having support ships developed and built.

Now the Navy has that depth operational capability in two oceans, the Atlantic and the Pacific. Last July divers based aboard the submarine rescue ship *USS Pigeon* (ASR-21) underwent nine days of decompression after a saturation dive of 260 meters. The ship and divers are based in San Diego, California.

In both instances the divers were compressed in a deck decompression chamber (DDC) outfitted as a habitat, then were taken to the bottom in a diving bell, from which they emerged to work on the seafloor. In this way they could work extended periods of time, remaining saturated at the 260 meter depth pressure whether on the bottom or resting in the DDC.

Oceonics Group Creates New Submersible Firm

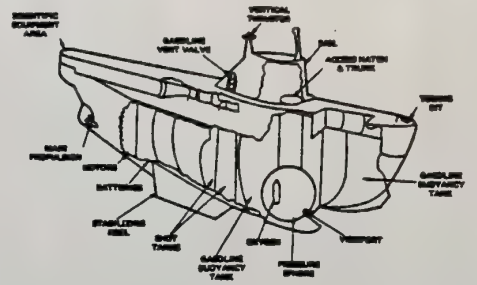
Oceanics Group PLC has acquired Ocean Team Services APS of Esjerg, Denmark, and formed a new company called Oceanics Submersibles Ltd. The new company will manage both Ocean Teams Services and Sub Spek Inspection Consultants Ltd., an Oceanics Group company.

Sub Spek, based in Aberdeen, Scotland, specializes in diving inspection mainly using underwater inspection vehicles. Ocean Team Service operates submersibles for rig support inspection and pipe line surveying.

))) **Broken Porthole Caused *Ocean Ranger* to Sink.** The U.S. Coast Guard has revealed that the semisubmersible drilling rig *Ocean Ranger* sank off Newfoundland in February, 1982, because of a broken porthole, short circuited controls and poor human response. Eighty-four men lost their lives in the sinking. After an 18 month inquiry the Coast Guard says that the tragedy might have been avoided had proper safety procedures been followed and the crew better equipped with safety gear. The rig's owner, Odeco International, was fined $25,000 for operating 50 days with an expired certificate of inspection and $100 for operating two days without two able-bodied seamen and a lifeboatman.

ARCHIMEDES

Designed to replace the FNRS-3 for the French Navy, the ARCHIMEDES was capable of 36,000 ft. dives with a 100,000ft. collapse depth. When the TRIESTE I was rebuilt, it became the only deep capability submersible in the world.
It was launched on July 27.1961 after construction had begun in 1957. On Jan. 26,1963 a French stamp was issued picturing the ARCHIMEDES and commemorating its achieving 9200m. Like the TRIESTE, the ARCHIMEDES is more properly a 'bathyscaphe', capable of mainly up-and-down balloon like dives with little maneuverability. The earliest known covers are for its operations between May-late July 1964 for OPERATION DEEPSCAN in the Puerto Rico Trench, 110 miles off Puerto Rico under the direction of Capt. Houot the ARCHIMEDES made 12 dives to a depth of 27,000ft. Cooperating agencies were the French Navy, Lamont Geological Observatory, Woods Hole Oceanographic Institution, and the USN Electronics Laboratory. Operating from the tender 'MARCEL le BIHAN' samples of rock and sediment were gathered. The two covers illustrated are for these operations. One is a printed (black) version and the other the OSC(magenta) type autographed by Houot and Froberville. The printed covers, numbered on the back into the 1000's came to light in a small quantity in the late 60's, and by whom,etc. and where prepared not known(?) An intriguing cover which also has another square cachet on the rever se. The OSC types are posted May until August at 10949EP(Puerto Rico).
In the May-July 1967 the ARCHIMEDES made nine dives in the Japan Trench to 9200m. with numerous covers posted Japan and France. Only a few received dive data,most just OSC and various cachets.
But these two series stand apart as the deepest operations after the TRIESTE Challenger series over last two decades and were beautifully historically documented for collectors.



Steel Mesh Suit Offers Shark Bite Protection

The "Shark Suit" invented by **Jeremiah Sullivan** is said to offer absolute protection against shark bite. Made by Neptunics Inc. of San Diego, it offers protection from sharks under 12 feet in length. which are responsible for most attacks.

The suits are made of a heavy steel mesh with small-diameter rings to prevent tooth penetration from those sharks with long, narrow teeth, such as the mako and sand tiger. Additionally, built into the suit is a system of rigid understructures to distribute the bite pressure over a larger area, thus diffusing the possibility of breakage. The understructure also reduces the animal's enthusiasm for a second bite.

Originally implemented for research in shark behavior a variety of commercial applications have surfaced. These include underwater salvage and construction crews. commercial fishermen. oil companies, air-sea rescue teams, military groups, scientists in other fields and film crews.

Gautier Will Manage Lockheed Advanced Marine Systems At San Diego

Robert H. Gautier

Lockheed Advanced Marine Systems of San Diego will be headed by **Robert H. Gautier,** president **Larry Smith** of Lockheed Shipbuilding & Construction Company, Seattle, has announced. Mr. **Gautier,** a long-time San Diego resident, will manage the operations at Harbor Island and Kearny Mesa. He retired from the U.S. Navy as a captain in 1975 after 30 years' service. At the time of retirement, he commanded the Naval Undersea Center, now the Naval Ocean Systems Center, and was a previous commander of Submarine Development Group One. Since retirement, he has been a consultant to private industry in anti-submarine warfare and undersea operations. He replaces **Robert A. Tyrrell,** who retired in 1983.

Mr. **Gautier,** a graduate of the U.S. Naval Academy in 1945 and the Armed Forces Staff College, served in destroyers, submarines, amphibious ships, and in operational and material positions on fleet staffs and on the staff of the Chief of Naval Operations.

CLEAN HARBOR BOTTOMS

An oceanographer at the Scripps Institution of Oceanography has discovered that a device shaped like an inverted wing, placed near the bottom of a harbor, can keep sediments suspended and moving, and provide a cheap and passive method of dredging. The device works by creating vortices in its wake which stir up and keep the bottom sediments moving to deeper water. Called a "vortex foil" by the inventor, Dr. Scott Jenkins, the wing is based on aerodynamic principles of the airfoil, or airplane wing. Tests of the wing have shown promising results.

Submarine Speed Measurement With Doppler Sonar

By Dudley Keyes
Director of Marketing
Sperry Electronic Systems Division

Last year alone, over 80,000 merchant vessels totalling more than 500 million gross tons were plying the world's trade routes. The sheer number of trading ships in service has grown by close to 100 percent in the last two decades. As the world's waterways become even more crowded, the demand for extremely accurate navigational instruments has increased. A modern mariner's efficiency, not to mention the safety of his cargo and crew, is heavily dependent upon the quality and type of navigational tools he uses.

Historically, vessel navigation on the world's oceans has been a matter of knowing one's direction and the distance travelled in that direction. Distance has been determined by measuring vessel speed and then multiplying it by the amount of time travelled at that speed. The science of navigation, therefore, can be considered as the measurement of speed, time, and direction appropriately applied by the mariner. Of the three navigational elements, speed measurement is the most difficult—especially during the process of "dead reckoning.

Marine navigation is made complex by the unknown and variable currents present in the world's oceans. Generally, the position of marine vessels is determined by the use of visual bearings, celestial or electronic navigation. During periods between position fixes, however, ships are navigated by the dead reckoning process: a method which establishes a ship's position from records of the course sailed, the distance made and the known or estimated drift.

Over the past several decades, industry has provided the mariner with improved direction-and time-determining tools. New speed-measuring devices have evolved more slowly, however.

History of Speed Measurement

Perhaps the earliest recorded attempt to measure vessel speed has been attributed to the Romans. Described by Vitruvius and said to be depicted on several coins of the era, Roman sailors utilized a paddle-wheel-type rotor with a revolution-counting device to measure distances travelled at sea. This primitive "hodometer" was developed from a similar apparatus used on chariot wheels to measure land journeys. The hodometer eventually gave way to the first legitimate speed "log."

During the formative years (late 1800s) of the marine industry, the classical "chip" log was used to measure vessel speed. This system consisted of a wooden chip attached to a line. The line had knots tied at regular intervals (fractions of a nautical mile) and was on a reel. The chip was lowered over the ship's stern and into the water where, by virtue of its shape, it remained relatively stationary. Speed could then be determined by counting the number of knots to pass over the ship's taffrail while sand ran through an hourglass.

Although the chip log represented a vast improvement over the Roman hodometer and other primitive instruments, it was still far from accurate. This resulted in large part from a lack of uniform distances. The meter, which is such a common unit of measurement today, varied greatly from one country to the next during the days of the chip log. As a consequence, consensus speed

Flush-mounted in the hull of a nuclear submarine, Sperry's DSVL uses three sonar beams to provide forward, vertical, and athwartship velocity measurements. DSVL outputs shown in the vector diagram illustrate the sub's three- dimensional path and speed.

measurements were nearly impossible to achieve. Also contributing to the chip log's inefficiency was its crude nature. Overused chips would often sink or the line itself would become entangled and snap. What mariners of this area really needed was a more precise speed log—one that would be able to both automate the rather tedious chip log methodology and produce universally standardized measurement results.

The Pitot-tube soon evolved as the heir-apparent to the classical chip log. Consisting of a tube having a short, right-angled bend, the Pitot log is placed vertically in water with the mouth of the bent tube directed towards the water flow. Used in conjunction with a manometer (pressure gauge), the Pitot log measures the fluid flow velocity, or ship speed through the water, by comparing the differences between recorded water pressures.

Yet the failings of the Pitot log were observed as early as 1933. Commenting in his book, *The Speed and Power of Ships*, author D.W. Taylor notes that, "The common Pitot-tube cannot be used to accurately determine ship speed (because) it is not practical to attach it to the ship in water that is undisturbed.

In fact, a ship disturbs water in two ways. First, the velocity and pressure in its vicinity vary because of streamline action. Second, the friction of the surface produces a turbulent layer adjacent to the ship where the motion is confused. The net result is a wake whose forward velocity, very close to the ship, is as great as 50 percent of the ship speed, and (which) rapidly dies away as we go out from the ship's surface." Due to these inaccuracies, and with the advance of new technologies, the electromagnetic velocity log was developed to replace the Pitot log.

Electro-Magnetic Velocity Log

The electro-magnetic, or EM log, is the speed-measuring device currently used on many ships. An EM log operates on the electromagnetic principle wherein a linear voltage proportional to speed is generated within an underwater sensor assembly and electronically converted to speed.

A typical EM log consists of this sensor and an electronics unit (Indicator Transmitter). The sensor is a rodmeter, or sword, that protrudes from the ship's hull. Within the sword is a coil of wire that sets up a magnetic field in the nearby water. The ship's motion through this magnetic field induces currents in the conductive sea water. As the water moves past the sensor, the magnetic field induces a voltage in the water which is picked up by two electrodes on the sword. The voltage is linearly proportional to the ship's speed through the water.

Unfortunately, the EM log is subject to several deficiencies which limit its measurement accuracy and operational utility.

The most fundamental limitation is common to all speed logs that sense a ship's motion relative to a water mass near its hull. Like the Pitot log, an EM log's speed measurement is subject to error because the water motion near the rodmeter is affected by the hydrodynamic flow fields generated by the ship's profile and movement. Compensation for these hydrodynamic effects requires complex calibration procedures since the flow characteristics at the sensor vary with sensor location, hull shape, speed, depth, and maneuvers.

Other limitations of the EM log include: a velocity measurement capability along the ship's longitudinal axis only (no athwartship velocity measurement); speed measurement; and marine fouling and breakage caused by the protrusion of the sensor sword. To combat these inadequacies, marine scientists and researchers began to experiment with Doppler sonars during the late '60s in an effort to create a more accurate speed log.

Commercial Doppler Sonars

The use of Doppler sonars for commercial marine navigation has increased considerably in recent years. Doppler sonars consist of keel-mounted transducers which send down pulsed sonic beams and convert the return signals into displays of ship speed—ahead and transverse. Specifically, a Doppler sonar operates by projecting an acoustic signal of known frequency into the water and measuring the frequency of the scattered return signal.

The frequency shift, caused by the Doppler effect, is directly proportional to ship speed. Present Doppler systems use a single transducer to transmit the acoustic signal and receive the acoustic reflection. Mounted flush with the hull, these transducers are not subject to the sensor damage associated with other speed log systems.

Doppler sonars are especially effective in determining a ship's velocity relative to the bottom in shallow water (less than 800 feet). At greater depths, a signal can be reflected off such targets as particles, bubbles, plankton, schools of fish, or other marine life.

According to the Society of Naval Architects and Marine Engineers, "Doppler sonars, with display arrows showing the direction of bow and stern movements, permit quick visual and quantitative evaluation of translation and rotational movement relative to the bottom. This is of particular use for large ships which make up to sea buoys or come to a pier, because in the very low speed range (less than a knot over ground) precise docking maneuvers are very difficult to judge."

U.S. Navy DSVL Development

A number of companies, including Sperry, Rosemont, Inc., Signet, Gould Inc., Sal Jungner Marine, and Edo Western, have been involved in the successful production of commercial speed logs.

The development of advanced speed-measuring devices for U.S. Navy ships and submarines have proven to be a more difficult undertaking, however. This situation is due primarily to stringent Navy specifications designed to satisfy complex mission, maneuver, and target motion analysis requirements.

Also, the movements of a submerged vessel or surface combatant demand measurement techniques not available in current speed logs. As a result, the Naval Sea System Command (NAVSEA), with technical assistance from the Naval Air Development Center (NADC), began a program to develop a Doppler Sonar Velocity Log (DSVL) for nuclear submarines (with applications to surface combatants) that will replace the EM logs currently in use.

The principal objectives of the DSVL engineering development program are to provide the U.S. Navy fleet with a highly accurate velocity sensor to improve the effectiveness of tactical forces, and to introduce a system with much better performance capabilities than the present EM log.

(Continued on page 28)

Program requirements that the DSVL must meet include:

- High accuracy, reliability, and maintainability.
- Measurement of forward, athwartship and vertical velocity components under both surface and submerged conditions.
- No accuracy degradation due to hydrodynamic effects during sophisticated mission maneuvers.
- Electronic calibration without external references and with long term stability.
- Application to all submarines and conventional surface craft requiring speed sensors.
- Direct interchange with EM log.

Program Justification

The feasibility of using Doppler sonar for velocity measurements on Navy ships was established through a variety of tests. Extensive experimentation was performed using commercial Doppler sonars in a tow tank; on a fresh-water lake; on the *U.S.S. Finback,* a nuclear attack submarine; and on the *U.S.S. Compass Island*, a large surface vessel used to evaluate navigational systems for the Navy's ballistic missile submarine fleet.

Each of these tests indicated a high velocity accuracy capability, with no degradation during maneuvers. Dead reckoning accuracy will also improve when using Doppler-derived velocity instead of data from the EM log. In addition, the tests aboard the *Compass Island* showed that the input of more accurate velocity data resulted in an improvement in the performance of the ship's inertial navigation system (SINS).

The submarine tests were performed while submerged in the Sargasso Sea, which is famous for its ultra-calm waters. These tests demonstrated Doppler sonar capabilities in very clean waters with low scatterer densities. No evidence of long-term drift or major system failures were observed during 2,800 hours of testing.

This extensive testing of commercial Doppler sonars demonstrated sufficient gains over the EM log as a ship speed sensor to warrant further development for eventual fleet applications. It also showed that with certain improvements (better electronics design, transducer design tailored for submarine use, interface compatibility with user equipments, etc.) a highly reliable military system could be produced with current technology. Accordingly, the program was advanced to a development phase, resulting in NAVSEA's selection of Sperry to produce the engineering development model DSVL.

Developmental Model DSVL

Sperry's DSVL uses the Doppler effect to measure ship velocity. The Doppler effect, or the shift in frequency of a reflected signal relative to the frequency of a transmitted signal, is directly proportional to ship speed. The company's DSVL is a three-unit system consisting of a transducer, a transceiver, and an electronics control unit (ECU).

The requirements for the transducer, which will emit three narrow acoustic beams, are that it be flush-mounted to the hull and that it fit into the existing nuclear submarine EM log rodmeter foundation. This requirement results in a transducer with a diameter of 2.75 inches and a 6-inch mounting flange.

To obtain the three narrow acoustic beams, the transducer will use a polystyrene lens to focus the emitted energy of three small crystals placed within the transducer housing. By utilizing these three beams, the DSVL will have a three-axis capability to measure longitudinal, athwartship, and vertical velocity components. Since return signals will be accepted only from scatterers at some distance from the hull, DSVL measurements will be minimally affected by hydrodynamic flow fields. Also, energy levels will be maintained as low as possible so as not to compromise covert mission capabilities.

DSVL Microprocessor

The microprocessor is the heart of the DSVL system, performing all computations, controlling all system timing, and generating all real-time functions and control signals.

Using temperature and pressure data from the transducer, it processes the difference between the Doppler-shifted speed and the reference counts into raw velocities along the three acoustic beam axes; transforms the velocity components along the ship's longitudinal, athwartship, and vertical axes; and with inputs from a stable reference, into horizontal and local vertical components. It then digitally filters the raw data to produce smoothed velocity estimates.

A major function of the microprocessor is system performance monitoring and fault detection and isolation, which will be achieved through an extensive BITE (Built-In Testing Equipment) capability. The BITE will detect and isolate failures down to a fault group using three digital displays.

The BITE can also detect transducer failure. This extensive use of BITE and Standard Electronic Modules (SEMs) is expected to keep the Mean-Time-To Repair (MTTR) below the Navy's required 30 minutes while simplifying future logistic support. The DSVL has a reliability goal of 3,500 hours.

While in the operational mode, the DSVL periodically cycles to a self-test mode, during which test signals are injected to exercise the receiver and processing circuitry. A preprogrammed sequence of tests is used to check the validity of signal characteristics at key points, the process culminating in a comparison test of speed along each axis versus stored limits.

The DSVL model has been designed so that an operator can manually select either water or bottom track modes of operation. Since there are no cases when the selected mode is not possible to achieve, a front panel display indicates the actual mode selected by the microprocessor. Located on the ECU, the DSVL front panel also reveals component velocities, total velocity magnitude, on-line monitor functions, and the BITE fault localization code. In addition, output data can be shown in synchro or digital form.

The fore, aft velocity will be distributed to user equipments in a manner identical to current EM log outposts so that no immediate modification will be required to user equipment.

Following Approval for Full Production (AFP), DSVL is planned to be installed on all classes of nuclear submarines, with potential applications to surface combatants.

Commercial Marine DNS

Using similar technologies, Sperry has also developed a Doppler Navigation Sonar (DNS) intended primarily for small submersibles and other marine vessels. The DNS utilizes two-axis (fore/aft and athwartship) sonar intelligence which, when coupled with accurate compass inputs, achieves continuous and highly accurate position and course data.

Specifically, this system provides a ship's navigator with constant real-time position data relative to a starting point on the ocean floor. It also continuously updates steering information to remain on a desired track. The DNS' bottom tracking capability has a range of 600 feet above the ocean floor. This system is ideally suited for a variety of surface and subsurface craft, including:

- oceanographic vessels
- geological survey vessels
- dredges
- oil pipeline inspection submersibles
- manned or remote underwater work vessels
- scientific submersibles.

HERE'S THE E-1 1-man submersible which is the prototype of the E-2. It's good for 150 meters and life support is rated at 50 man hours. Propulsion is by 2 independent electromotors of 500 W each, placed laterally and capable of being rotated 360°. Cruising speed is 2 knots and she can lift 508 lbs. There is a hemispherical acrylic dome and a viewport in the bow.

It was originally called the "Europe-1" submersible. The E-2 goes a bit deeper (210m) Markasub in Basel, Switzerland is marketing the subs, emphasizing their simple, rugged design, high reliability and low maintenance costs. The E-2 was on display at Brighton.

NEW UNDERWATER WELDING TOOL

The Subsea Group of companies, including Subsea Offshore and Subsea International, have entered into an agreement with Thompson Welding and Inspection Ltd. of Inverness for the exclusive rights to market, operate and manufacture a unique underwater friction welding tool on a worldwide basis. The tool, developed after 3 years of R&D by Thompson and the Welding Institute, will be offered to offshore operators as one of the many underwater engineering services provided by Subsea. Primary applications are anode installations where the welded stud provides structural support and electrical continuity, installation of sheer keys for grouted clamps, hot taps for small diameter piping and installation of cat eyes and other devices for rigging and salvage. Friction welding produces unparalleled metallurgical integrity with similar or dissimilar metals. The process requires no precleaning of underwater members. The stud will first penetrate marine growth, epoxy coatings, or other objects prior to fusing with the steel member to which it is welded. It is the only tool of its kind on the world wide market today and the process has been successfully tested to 1,000 ft.

INTRODUCING PIONEER, a new ROV designed and built by Sub Sea Offshore. Employing 2 forward, 2 lateral and 1 vertical thrusters, PIONEER is claimed to be the most powerful ROV in the market for its size. Incidentally, the thrusters (Innerspace units) and the sonar (Straza Model 250) are the only non-British items on this ROV (at the Sub Sea stand in Aberdeen show there was a sign saying "Sub Sea Pioneer Unmanned Submersible Designed, Developed and Built in Britain by Sub Sea"). It is rated to 5,000 ft. Dimensions are 65" high, wide and long. Comes with auto depth/heading, TV camera, sonar, 5-function manipulator, multiplex and more.

Sub Sea reps said that 2 are built and there will be 4 more by January 1984. It looks like Sub Sea will be ending their dependency on US and Canadian built ROVs. Unit cost is thought to be about $500,000. Sub Sea has no plans to sell to competing service firms.

HARBOR BRANCH SUCCESS

Two research submersibles of Harbor Branch Foundation successfully completed test dives down to 2,640 feet in the Bahamas recently. The submersibles will be reclassified to an additional 640 feet from their previous rated depth of 2,000 feet.

Research vessels JOHNSON and SEA DIVER departed Link Port for the Bahama Islands on April 1 carrying the subs on their sterns. After performing a series of preliminary dives, the crews conducted the final test dives 10 miles southeast of Freeport, Grand Bahama Island. Under the observation of an American Bureau of Shipping (ABS) surveyor, each sub descended slowly to the new operating depth of 2,640 feet to insure that all systems functioned properly. All systems on the subs were critically checked at periodic depth increments during the descent.

Harbor Branch Marine Operations Director **Roger Cook** said that final results indicate all systems functioned properly. The sub pilots were **Marshall Flake** and **Tim Askew.**

IUC MANTIS LOSES UMBILICAL

Recently, IUC's Mantis (in its manned configuration) performed an unscheduled demonstration of one of its unique safety features. This is its capability to jettison its umbilical and become a free-swimming vehicle with emergency batteries providing power for thrusters and lights.

During a normal BOP and Riser inspection to a depth of almost 430 ft, in support of the *Diamond M General* deepwater drilling program offshore California, as the pilot started to maneuver to the other side of the BOP to start his ascent, the vehicle's umbilical became wedged within the BOP. Unaware that its umbilical was wedged, the Mantis pilot directed the surface to take up some of the slack. As the slack was being taken out, the heave of the drillship, due to 6 to 8 ft swells, stressed the umbilical and it severed at the point it was wedged.

On the surface, communications were switched immediately to the backup acoustic link. Within the Mantis, the pilot switched to his emergency battery power, shut down all non-critical systems and started to maneuver to the riser so that he could follow it up to the surface. The Mantis made a controlled ascent, surfacing next to the riser. Due to the danger of being smashed against one of the rig's structural supports, the pilot flew the Mantis on the surface outside the rig to the stern where the surface crew was rigging a personnel basket and sling on the stern crane.

As the 2 divers were being lowered to the water's surface, the Mantis pilot was able to maintain his position so they could just jump in and hook up the recovery line.

From the time the umbilical parted to when the Mantis was lowered to the deck took a total of 30 minutes. The incident reconfirms IUC's confidence in the safety features of the Mantis system and its capabilities to provide safe deep diving services without the need of any type backup vehicle.

IUC's Mantis is a single vehicle with the ability to operate as either a standard ROV or as a manned one-atmosphere tethered vehicle. In both the unmanned and manned modes it has successfully completed multiple working dives in each mode to a depth of 1,970 ft in the Gulf of Mexico on The *Penrod 75*.

Mini-sub dives off Mendocino to hunt for oceanic mother lode

By Alan Cline
Examiner staff writer

No one knows for sure that the mountains stand exactly where they appear to. And no one knows precisely what inhabits their recesses or may be mined from them.

But the prospect of previously unrecognized life forms and a wealth of underwater minerals off the Northern California coast will lead marine geologist Alexander Malahoff and two others into the 10,000-foot depths of the Gorda Ridge in July in a mini-sub called Alvin.

The two dives off the Mendocino coast reflect the United States' renewed interest in ocean minerals and hold the promise of an underwater Louisiana Purchase, some say.

No one has yet plumbed the depths of the Gorda, but the terrain 120 miles offshore has similarities to Pacific bottom areas already surveyed.

It is in the ocean floor's special environment — where molten material meets lightless cold water — that unusual life forms have been found. So-called "polymetallic sulfides" created under the same conditions may offer new wealth in special metals. For that, the United States has dramatically expanded its claims to the ocean.

"We saw fairly large worm colonies halfway up the Juan De Fuca Ridge (north of the Gorda)," said Malahoff, a marine geologist who has been studying ocean floors for 21 years.

Clams, crabs and other crustacea also have been sighted in the lightless depths. William Normark, a United State Geological Survey marine biologist who has dived along the Juan De Fuca Ridge, talks of sighting inch-thick whiteworms up to 15 feet long there.

"Many of the animals found in these dives represent entire new families," Normark said. "Biologists are still debating whether one of the worms represents a whole new phylum (one of the broad, basic divisions of the animal kingdom). It's been 50-60 years since anyone has found a new phylum."

Malahoff, making his final dive as a government employee before rejoining the University of Hawaii oceanographic faculty, will leave San Diego July 4 with Alvin on the mother ship, Atlantis II, out of Woods Hole, Mass. Fifteen scientists will be aboard.

The mission involves not only diving and collecting hundreds of pounds of rocks, minerals and samples of bottom life, but the systematic mapping of the crests of sea bottom ridges from the Mexican to the Canadian border.

The Atlantis II voyage follows the British research ship Farnella, now working with the U.S. Geological Survey mapping 1 million square miles of ocean bottom off the coast.

The mapping surveys include areas off Southern California where phosphates may be mined for fertilizer. Potential oil and gas locations off the Big Sur coast and in the subterranean Monterey Canyon off Monterey Bay also will be mapped.

The geologists need the maps to determine which areas deserve further attention and which should be avoided.

Interest in mining the ocean floor was heightened last year after President Reagan proclaimed an American Exclusive Economic Zone, extending 200 miles into bordering waters.

Within the zone, the United States has, "to the extent permitted by international law, sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil," Reagan declared.

While that declaration disrupted ongoing negotiations for a new international law of the sea, it also established America's broader sovereign interest in ocean floor resources.

Last month, the National Oceanic and Atmospheric Administration removed Monterey Bay as a candidate for marine sanctuary status after about seven years on the "maybe" list. Supporters of such protection blame the action on renewed interest in offshore minerals.

"It's like we just made the Louisiana Purchase and sent out a Lewis and Clark expedition to find out what we have," said Conrad Welling, a senior vice president of Ocean Research, The Lockheed affiliate in Mountain View is working with several oil companies to find metallic nodules in the north-central Pacific between Hawaii and Baja California. Those nodules contain nickel, copper, cobalt and manganese.

Mining the nodules is on hold because of a deep recession in the metals market. Welling predicts mining operations won't get under way for at least 10 years. However, his company hopes to obtain an exploration license this fall permitting the consortium to mine areas of its choice when economic conditions are more favorable. He estimates a mining operation would require $2 billion.

The polymetallic sulphides containing lead, iron, copper and nickel already have been located in the Juan De Fuca Ridge, and that's what Malahoff will be investigating.

The U.S. Department of Interior last year scheduled a Gorda lease sale, then canceled it after reducing the lease area by 90 percent to about 4 million acres.

Interior Secretary William P. Clark said during a stopover last week in San Francisco that his department now has no timetable and no plans for leasing any of the Gorda.

"We're looking not for what we need today but for tomorrow," said Reid Stone, Interior's manager for the deep-sea mining program. He foresees a 20-year delay before mining the seabeds begins.

That's fine with environmentalists and Northern California commercial fishing interests, who oppose any mining program in the Gorda.

The Oceanic Society, along with the Natural Resources Defense Council, asked more than 50 specialists from universities, research institutions and government to review a 579-page draft of a government environmental impact statement on mining the Gorda. Results were solidly negative.

The consensus was that a lack of critical scientific data exists in the areas of geology, physical oceanography, biology and mining technology.

At the urging of North Coast lawmakers, the state Assembly adopted a resolution seeking a five-year delay on leasing in the Gorda and similar legislation is pending in Congress.

A major fear is the potential release of toxic materials into the ocean during the various stages of the mining activity.

More than 100 fishermen testified at one public hearing on the draft impact statement. The consensus: sit tight until 1988, when more is known about both the ocean floor and mining technology.

U.S. Cuts Back and Delays Giant Undersea Lease Sale

By Charles Petit
Science Correspondent

A controversial federal plan to open the undersea Gorda Ridge canyon off Northern California and Oregon to mineral prospecting will be greatly reduced and delayed until at least next year, Interior Department officials said yesterday.

The lease sale, previously set for September on a 40 million acre tract of volcano-studded sea floor as much as two miles under the surface, will now involve 4 million acres at most and will not be held until March 1985 at the earliest, the officials said.

The proposed area is between 100 and 200 miles from shore, running from Cape Mendocino on the south to mid-Oregon.

The lease sale has been opposed by several environmental and fishing groups as a risky scheme to "strip-mine" the ocean floor. The delay came after a meeting Tuesday in Washington between Secretary of the Interior William Clark and Oregon Governor Victor Atiyeh.

Clark said a joint task force between his department and Oregon will re-examine the "economic, engineering, and environmental aspects" of the plan. The task force will be headed by Robert Beauchamp of the Interior Department's Minerals Management Service, and Oregon state geologist Donald Hull.

Government officials have said that the Gorda Ridge offers the potential of easing U.S. dependence on foreign sources for some strategic minerals such as nickel, copper and cobalt.

The man in charge of the Gorda Ridge sale, Reid T. Stone of the Minerals Management Service office in Los Angeles, said yesterday that the door is open for California officials to join the review.

"I have made the same offer to California and they are still considering it," Stone said. "But, apparently due to the size of the California government, it takes them longer to respond. We are hopeful that California will join us."

Stone also said, however, that if California does not join the task force, portions of the proposed lease sale off California's shore will probably be dropped from consideration.

The delay comes after the depressed mining industry gave the lease sale a lukewarm reception.

The delay also allows government exploration of the Gorda Ridge by the manned research submarine Alvin, planned for late this summer. The exploration is to be completed with results available to private companies well before competitive bidding for prospecting rights.

Richer Deep-Sea Mineral Deposits Found in South Pacific

Preliminary deep-water sampling of mineral-rich crusts on the sea floor between the Hawaiian islands and Samoa has located deposits of cobalt, nickel and manganese that are richer than previous samples, according to marine geologists aboard the U.S. Geological Survey research vessel *S.P. Lee.*

Scientists from the Interior Department agency said that thin pieces of crust dredged from a seamount about 260 kilometers northwest of Palmyra Atoll and Kingman Reef, United States territorial possessions about midway between Honolulu and American Samoa, had a cobalt concentration of about 2.5 percent, more than twice the concentration that earlier reconnaissance studies had indicated. The rock samples also contained significant quantities of nickel (0.8 percent) and manganese (32 percent).

The USGS scientists, who are currently working cooperatively with scientists from the Federal Republic of Germany (FRG), said that although the richer mineral content of initial samplings is encouraging, thicker sections of crusts with such high mineral content are difficult to find consistently.

From earlier reconnaissance studies by the USGS and the FRG in 1982, scientists had expected concentrations of cobalt of 1 percent or more and concentrations of nickel of 0.5 percent, and of manganese of 25 percent.

These preliminary findings are especially important because the areas in which the metal-rich deposits are found are part of the nearly 4 billion acres of relatively unexplored ocean bottom comprising the recently proclaimed U.S. Exclusive Economic Zone.

Modified *Mantis* Submersible Sets 600-Meter Depth Record

A converted *Mantis* submersible, operated by International Underwater contractors, Inc. (City Island, New York), has established a new water depth record for one-man, one-atmosphere systems in the U.S. According to Andre Galerne, IUC president, the new *ROV Mantis* dove to 600 meters while performing deepwater exploration tasks for Conoco Offshore Louisiana in support of *Penrod 75* rig.

The "unique feature separating it from other remotely operated *Mantis* vehicles, including the *Mantis Duplus*, is that it is equipped with eight AC thrusters and four DC thrusters, which makes it the most powerful *ROV Mantis* to date," Galerne said.

The firm said it is now negotiating to convert another standard *Mantis*, which will be ready for offshore assignment in early spring of this year.

Tuneable Hull Plate Reduces Propeller-Induced Noise/Vibration

Propeller-induced noise and vibration can be a serious problem particularly on smaller, higher-speed vessels. If intense enough, these foreign forces reduce power and fuel economy, add to the discomfort of passengers and crew and can negatively influence the operation of shipboard electronics and other equipment.

The problem is traceable to the ratio of propeller power to ship weight; as power increases on lighter weight ships, the problem is amplified.

One recent solution to the problem is a CIRR-PSA system (patent pending), developed by **Pal Francis Hansen,** that is designed to reduce the transmission of the propeller shocks into the hull structure of the vessel from 60 to 90 percent. The design is predicated on the vibration and shock absorbing characteristics of helical wire rope isolators supplied by Aeroflex International Corporation.

The CIRR-PSA system entails a box built into the hull immediately above the propeller tip, Figure 1. The hull plate of the PSA box has the same shape and contour as the surrounding bottom plating, and is flexibly mounted on helical isolators located inside the box, Figure 2. The flexible hull plate mass, combined with specific shock and vibration capabilities of the isolators, provides a specific damping level. To tune the system for any particular installation, it is only necessary to alter the hull plate mass and select the correct isolators.

Figure 1—Shown as viewed from aft is the hull plate mounted above the propeller and the elastomeric seal surrounding the hull plate.

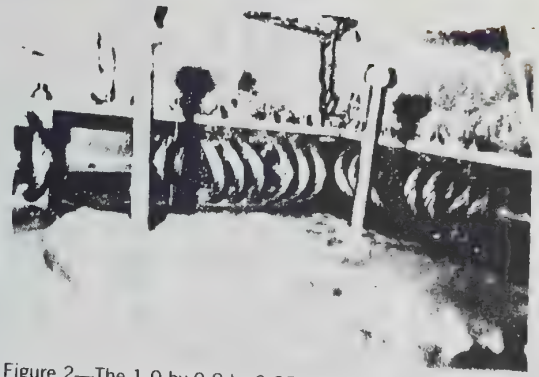


Figure 2—The 1.0 by 0.8 by 0.25 meter box houses the four-wire rope isolators. By adjusting hull plate mass and selecting isolators exhibiting specific damping characteristics, the system can be tuned for several ship sizes.

Propeller-induced turbulance establishes force levels acting upon the hull plate. The hull plate moves against the counter force produced by the isolators, reducing the amount of vibration that migrates into the ship's hull.

Acceleration measurements in the aft body have shown up to 90 percent reduction of vibration amplitudes after installation of the flexible-seated PSA hull plate in the nearby structure at specific propeller-blade frequencies.

The helical isolators are sealed inside the box by a special watertight double rubber seal. The elastomer material is flexible enough to permit smooth movement of the hull plate with low drag at the point of isolation force crossover.

Helical wire-rope isolators are stable mounting assemblies of stranded-steel wire rope formed between metal retainers, Figure 3. Their large dynamic displacement attenuates heavy shocks, while their inherent damping enables them to absorb and dissipate large amounts of low- and high-frequency vibration. Of particular importance for motion control at resonance is their flexure hysteresis.

Damping characteristics are related to the strain applied to the isolator. Large motions are highly damped, whereas small amplitude motion is moderately damped with the isolator appearing to act as a nonlineal element. The cable is wound in a helical fashion between two metal bars to assure shock and vibration control, regardless of the direction of applied force.

Figure 3—The helical isolators are stable mounting assemblies of high-quality stranded wire rope held between metal retainers. Each isolating element has specific response characteristics determined by its design.

The helical cable isolators resist destructive environments because they are made entirely of stainless steel or stainless-steel and corrosion-resistant aluminum alloy; or even more exotic metals such as Inconel. The isolators require little or no maintenance and usually will outlast the equipment they isolate. They also can be painted to match equipment.

A prototype of the system is in operation onboard a new high-speed rescue vessel, R/S Olav V, operated by the Norwegian Sea Rescue Service. The vessel is equipped with twin 1,500-hp engines; propellers have a 1.20 meter diameter.

The CIRR-PSA system will be delivered with isolators, seal and an engineering package with all technical data necessary to build a PSA system for a specific project.

Don Walsh—Deep Submergence Pioneer

By Larry L. Booda
Senior Editor

Don Walsh wanted to be a naval aviator. That was his goal while he attended the U.S. Naval Academy, from which he was graduated in 1954.

It was soon after that a quirk of fate guided Walsh to a career initially as a submariner. The flight surgeons declared that his eyes couldn't pass muster for aviation training. To this day he maintains a high level of interest in flying.

Walsh projects his lively intellect on a wide variety of subjects but with a primary focus on the oceans, especially National Ocean Policy. For his recent ideas see the *Sea Technology* "Soapbox" for August 1983, page 85.

In the late 1950s Walsh became involved in the Navy's deep submergence program. Its activities were concentrated on operations of the bathyscaphe *Trieste I*. In Project Nekton, the submersible was taken to the western Pacific.

After a series of ever deeper test dives Walsh, then a lieutenant, and Dr. Jacques Piccard, on January 23, 1960, dove it to the bottom of the Challenger Deep of the Marianas Trench. It is the deepest spot in the oceans, 10,912 meters (35,800 feet). It is a record that can only be equalled, never broken.

As with many other submariners of the time, Walsh had to make the choice of taking the nuclear power route in his submarine career or seeking some other postgraduate education track.

In the 1960s the Navy would permit an officer to take postgraduate courses in non-Navy schools but wouldn't pay the tuition. Walsh applied for admission to the graduate school of Texas A&M University.

To meet the costs of his education he began lecturing on oceanography and the oceans. He is a relaxed and natural speaker with a sense of humor. In three years he earned his Ph.D. in oceanography, paid for by his nationwide lecture tours.

While still on active duty he was sent by the State Department to lecture overseas, acting as a goodwill ambassador of the oceans. He also spent a year at the Woodrow Wilson Center for Scholars, housed in the Smithsonian Institution's "Castle," but not connected with the institution. There he had a chance to work with great intellects, write and deliver more lectures.

It soon became apparent that Walsh's career track wasn't exactly what could lead him to flag rank, even though he had served a tour of duty as the commanding officer of a deep draft ship.

In his lecture tours Walsh had become acquainted with the William P. Wrigley Foundation, a substantial supporter of the University of Southern California.

He had formed the idea of establishing an Institute for Marine and Coastal Studies (IMCS). His proposal to the university and the foundation, after a lengthy evaluation, was accepted. Concomitantly, his request for retirement from the Navy was approved. Thus Walsh began his second career in 1975.

About the same time another submariner and close friend, Don Keach, retired from the Navy and joined IMCS.

As IMCS grew and became known, Walsh and Keach formed a company, International Maritime, Inc., as a sideline deep submergence consulting firm. This led to multiple trips for both men to Japan and the Soviet Union.

Walsh's restless mind again was in ferment in 1981 and 1982. In February 1983, he notified the university administration that he wanted to resign.

After eight years, he said, it was time for a change in the IMCS leadership and suggested that the change be made at the beginning of the academic year. It was accepted and Walsh stepped down last November 15. Keach, who was deputy director, remains as administrative director.

Thus Walsh is launched on a third career following the military and academia. He continues his interest in the Marine Board of the National Academy of Engineering and his activities as a member of the National Advisory Committee on Oceans and Atmosphere (NACOA). At NACOA meetings he is noted for serious deliberations and for doodling professional quality cartoons, some funny and some devastatingly satirical.

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

MAY, 1985

Vol. XVIII, No. 1, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned deep submersible vehicle design, operation, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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EDITORIAL NOTES AND COMMENTS

I hate to see a grown man cry Department ..... A year has elapsed since time, energy, and my typewriter coincided to produce the previous Newsletter. Not only has my excitement ebbed due to lack of involvement or even contact with our "trade" up here in this mid-California backwater, but I have received little in the way of expression of interest from Members. In fact, I have elicited no response at all to several direct multiple and individual requests for information to include in the "next" Newsletter. Has the Membership become so apathetic in the face of an ROV takeover or have manned operations become so commonplace that our Association no longer has a reason to exist? I sincerely hope this perception is all wrong, in which case I undoubtedly will receive several offers immediately from volunteers eager to assume the mantle of Editor which I accepted from Larry Megow ten years ago.

DEEP QUEST deep six (or From down under to Down Under)..... Don Saner retired in September '84 from Lockheed where he was the last of of the DEEP QUEST pilots. He and wife Joyce will be leaving San Diego in August '85 for a year in Australia where they met when Don was a submarine crew member in WW II.

Bubbles is his name, bubbles are his game ..... Will Forman has become fully involved in directing the Aquanautics project to produce a synthetic gill system to extract oxygen from sea water. This will free the SCUBA diver from tank capacity limitations, with an ultimate goal, as I understand it, of permitting the unlimited operation of internal combustion machinery on a fully submerged vehicle. Exciting!

Hats Off! Department .... Research Submersibles, Ltd. (see reprint of article by Robyn Janca in this Newsletter) is truly the most fascinating development in recent submersible news. Good luck and great success to RSL!

Too late for posthaste .... Last June, I received letters from David Mathis of 27 William St., Lakewood, NJ, requesting that the Newsletter publicize the need for DSPA Members to support the drive to have the U. S. Postal Service issue a stamp commemorating the 25th anniversary on 23 January 1985 of the "record ocean descent in the Challenger Deep of the Marianas Trench, 250 miles southwest of Guam , when the U. S. Navy Bathyscaphe TRIESTE I, manned by Dr. Jacques Piccard and Lt. Donald Walsh, USN, reached the Pacific Ocean bed 35,800 feet down, an achievement equivalent to man's first solo transatlantic flight or man's first moon walk". The Citizens' Stamp Advisory Committee apparently found a quota of more earth shattering events to commemorate. I regret that we missed the chance to make ourselves heard.

NEWS FROM MEMBERS

(Editor's note: believe it or not, this is all the news that I have received in the last year except for a couple of phone calls from Will Forman and Don Saner.)

Will Forman, DSPA (22 May 1984)

"The monthly luncheon on 17 May was scheduled to be a business meeting, but Son Walsh brought in some welcome guests from ROV '84. These included former associates Andy Rechnitzer (TRIESTE) and Bill Rainnie (ALVIN). Kenji Okamuraof Japan presented us with an overview of SHINKAI 2000 and its over 100 dives to date, plus plans for SHINKAI 6000. Jean Jarry of France told us of SM 97's design and diving capabilities to 6000 meters and the design and operating characteristics of ARGENETTE, now named SAGA. It is now planned for use in the North Sea oil fields as a mobile, all-weather, diver lock-out submersible platform. Graham Hawkes and Sylvia Earle of Deep Ocean Engineering described the all-plastic hulled DEEP ROVER, soon to be launched. Our guest speaker, Anotoly Sagalevitch, Head of the USSR Laboratory of Manned Submersibles, told of the two PISCES (7 and 11) that are used in Russia to dive in pairs. Mr. Victor Brovko addompanied him in the US and is a designer and pilot of ARGUS as well as a pilot of PISCES. Anatoly described a dive in the Red Sea where,near the bottom. the salinity was almost five times normal and the water was like glycerine. The density reflected sonar for a false bottom indication and absolutely prevented

further penetration with PISCES. They observed underwater internal waves below 1000 ft. that behaved like seashore waves on the sloping edge of the basin in which the dived. There were twenty-one present at the luncheon, nine of whom were Members. Two of the visitors were ladies. It was an interesting international meeting. John Schiltz reported that ROV '84 had twice as many exhibits as ROV '83 and that ROV '85 is also planned for San Diego."

David Hudacek, ex-USN (8 August 1984)
"I have finally settled here in Seattle in preparation for returning to graduate school at the University of Washington. Am in the process of affiliating with the Naval Reserve Unit at Keyport. That should keep me active and abreast of things while I'm in school. New address: 2366 Yale Avenue East, Apt. 5
Seattle, WA 98102
(206) 324-6224 "

Larry Megow, Hahn & Clay(12 July 1984)
"Attached is a Houston Post news item about 'our' ALVIN. I say 'our' because we manufactured ALVIN's original HY-100 hull in '64."

PORTLAND, Ore. (AP) — Three men whose submarine descended deeper than ever before to the northeast Pacific Ocean floor say they saw remnants of volcanoes in an undersea mountain range that's part of an area proposed for mining.

"If you can imagine it, much of the ocean floor there looks like a snowy landscape in New Hampshire or Vermont," said Alexander Malahoff, a National Oceanographic and Atmospheric Administration geophysicist leading an expedition exploring the Gorda Ridge.

The ridge is an ocean-floor mountain range off Oregon and Northern California that is part of a 70,000-square-mile area the U.S. Mineral Management Service has suggested for undersea mining.

Malahoff and Robert Embley, a geophysicist and marine geologist with the agency, descended Monday almost two miles below the waves about 160 miles west of Crescent City, Calif.

Piloting the dive was James Hardiman of the Woods Hole Oceanographic Institution, which operates the 16-ton submarine named "Alvin" from a base in Woods Hole, Mass.

Alvin departed the Atlantis II, its 2,300-ton support ship, at 10 a.m. and dived to the southern section of the Gorda Ridge. The 22-foot submarine traveled about a mile along the ocean floor before returning to the surface at 6 p.m.

"We didn't see any evidence of any recent volcanism or minerals, but this today was only our first dive," Embley said during a radio interview with The Oregonian of Portland shortly after the men emerged.

Four more dives are planned along the ridge before the 14 scientists aboard Atlantis II begin dives to the Juan de Fuca Ridge, an undersea range off Oregon and Washington.

Malahoff and Embley said they had expected to find evidence of recent mineral deposits and hot-water vents like those associated with exotic marine life on the Juan de Fuca Ridge. But the light-colored rocks on the Gorda Ridge were sedimentary, along with large chunks of old volcanic rock known as pillow basalt, they said.

"What surprises us is that the Gorda Ridge does not appear to have as extensive magma building as the Juan de Fuca," Malahoff said.

The water temperature was about 34 degrees, and the pressure was "several thousand tons per square inch," Malahoff said.

"Once you get into total darkness below 200 feet, the ocean water is filled with luminescent animals," Malahoff said. "When you look out the window, they all flash. You have the feeling of diving through stars."

Larry Megow, Hahn & Clay (17 July 1984)
"Attached is an interesting Mitsui news release about a spectacular development for underwater research.

MITSUI ENGINEERING &
SHIPBUILDING CO., LTD.

HEAD OFFICE: 6-4, Tsukiji 5-chome,
Chuo-ku, Tokyo 104, Japan
Telex: J22821, J22924

MES
BULLETIN

IMMEDIATE

MZ 840531-772

MES "KAIYO"

MES-Built SSC Type Support Vessel for Underwater Work Experiments Christened "KAIYO"

Tokyo, June 28 -- The SSC (semi-submerged catamaran) type underwater work vessel (Hull No. 1274), under construction at the MES Chiba Works for the Japan Marine Science and Technology Center was named the "KAIYO" at her christening ceremony held on May 31, 1984. In the presence of many distinguished guests at the ceremony, Mr. Michiyuki Isurugi, Director-General of the Science and Technology Agency unveiled the ship's name while Mrs. Isurugi cut the line.

The KAIYO will serve to help in developing new diving techniques and in obtaining highly precise test results in various research and development projects as well as in oceanographic surveys.

The "KAIYO" is designed as a diver support craft equipped with a submersible decompression chamber (SDC) and a deck decompression chamber (DDC). She will be the first Japanese exclusive support vessel that can maintain a position for a long period of time and function as a base for offshore experiments.

The "KAIYO" is scheduled for completion in May 1985.

Features of the SSC Type Underwater Work Experiments Support Vessel:

1. Excels in stability at sea; work can be safe, dependable, efficient and accurate; favorable working environment for research staff on board; and reduces seasickness.
2. Ready storage on spacious work deck of gas cylinders and other equipment used for experiments. This improves safety measures during operations.

3. Provided with the first Japanese-produced dynamic positioning system (DPS) to achieve computerized thruster control which enables vessel to maintain a fixed position. This allows divers to continue working safely for many hours at greater depths.

4. Being electrically propelled, all vibration or noise producing equipment including engines are located on upper deck. This reduces underwater noise and enables accurate data to be obtained from underwater communications and measuring instruments.

5. A large opening can be provided in midship deck, where the least ship motion occurs, to allow SDC and other items to be easily lowered into or lifted out of water from a safe position.

Major Equipment

1. Submersible decompression chamber (SDC) and deck decompression chamber (DDC).

2. Dynamic positioning system (DPS).

3. Others:

   a. Precise navigation system; Microwave and acousic positioning system and radio navigation system.

   b. Multi-narrow beam echo sounder.

   c. Meteorological system.

Principal Particulars:

Length p.p.	53.0 m (180')
Gross tonnage	2,800 tons
Breadth mld.	28.0 m (95')
Depth mld.	10.6 m (36')
Maximum draft	6.3 m (25')
Service speed under full load	12 knots
Navigation area	Ocean/International voyage
Complement: Crew-29, Research personnel-40	

Larry Megow, Hahn & Clay (14 February 1985)
"Attached is a Kawasaki news release that should be of considerable interest to several of our pilots."

KAWASAKI TOPICS
NO. 152 1984
KAWASAKI HEAVY INDUSTRIES, LTD

Japan's first Deep Submergence Rescue Vehicle launched at our Kobe shipyard for delivering to Japan Defense Agency

The launching ceremony of the Japan's first Deep Submergence Rescue Vehicle (DSRV) recently took place at our Kobe Works. In the ceremony, Director General Takashi Ueno, Central Procurement Office, Japan Defense Agency, cut the holding rope.

The keel of the DSRV was laid on December 15, 1982 and its completion is set for March, 1985.

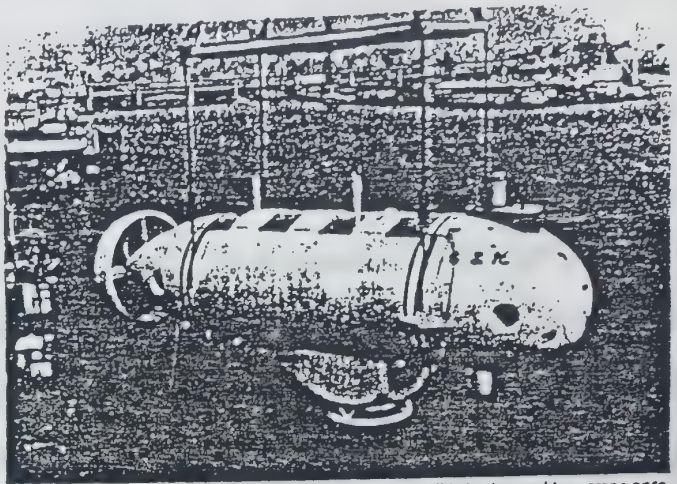
The DSRV was developed for the purpose to rescue crews from distressed submarines. Once an accident happens, it is brought to a disaster point by mother ship. After leaving the ship, the DSRV will approach to the distressed submarine following the instructions from the mother ship and by its own sonar system.

When the DSRV locates the distressed submarine, it will connect its transfer skirt to the hatch of the submarine by its trim/heel control system, maneuvering control system (including automatic position keeping mode) and mating system enabling the crew move into the DSRV.

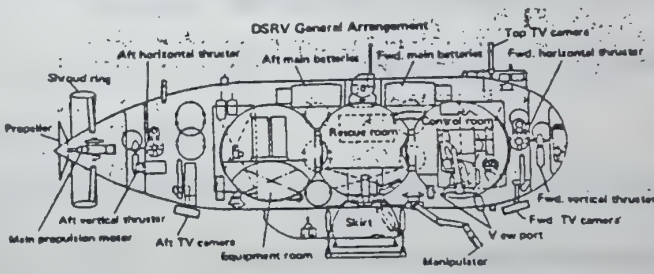
Three spheres, composed of ultra high-tensile strength steel, are connected to form the tri-spherical pressure hull in which a control room, a rescue room and an equipment room are arranged. A hemispherical transfer skirt is attached on the bottom of the rescue room.

Titanium alloy, pure titanium and FRP are used for the outer hull. Equipments are well arranged outside the pressure hull so as to utilize buoyancy and inside space to maximum. In order to accomplish the urgent mission to save a life, main equipments are installed to be easy for quick check and their reliability has been increased through adapting dual system.

Thus, the DSRV is a highly-advanced, complicated submergence vehicle, and very high-grade technologies are required for its construction. These technologies are believed to become a great help in building various submergence vehicles and under-the-sea equipments which are necessary for furthering ocean development, researching deep sea mineral resources such as manganese nodules and hydrothermal deposits, or ocean trench for earthquake prediction.



Japan's first deep submergence rescue vehicle "Chiyoda," being lowered by a crane onto the sea at KHI's Kobe Works.



Principal particulars of the DSRV

Length o.a.	: 12.4 m
Breadth	: 3.2 m
Depth	: 4.3 m
Displacement	: abt. 40 t
Cruising speed max.	: 4 knots
Pilot	: 2 men
Propulsion system	:

Main forward propulsion is provided by a stern mounted reversible propeller, with an AC motor, oil-filled and pressure compensated. A shroud ring around the propeller can be tilted to provide pitch and yaw motion. 4 ducted thrusters, 2 vertical and 2 horizontal, each is driven by an AC motor, oil-filled and pressure compensated.

Pressure hull :
Three spheres composed of ultra high-tensile strength steel

Outer hull :
Framework titanium alloy and pure titanium
Outer skin FRP

Viewing port :
2 ports made of methacrylic resin

TV camera : 5 sets

Manipulator :
One, hydraulically-powered, 7 degrees-of-freedom ●

Larry Megow, Hahn & Clay (8 April 1985)
"I do hope someone sends you more complete information on "our" SEA CLIFF's historic and long-sought after 20,000'dive."

The Houston Post/Sat., April 6, 1985/

WASHINGTON (UPI) — The Sea Cliff, a deep submergence research vehicle, recently completed a successful dive of 20,000 feet off the Pacific coast of Central America, the Navy announced Friday.

The 21-ton, 25-foot-long submersible is believed to be the only underwater boat of its class that can now operate independently at 20,000 feet "or more," the Navy said.

The dive into the Middle America Trench was the last in a series of depth tests following a redesign incorporating a titanium hull and silver zinc battery.

The Navy did not say when the Sea Cliff dive was made or how many men were aboard.

Originally designed to operate at depths of 6,500 feet, the Sea Cliff can carry up to three men — the pilot and two observers.

The Navy said the vehicle's new operating level provides access to more than 98 percent of the world's ocean floor. Sea Cliff, one of two identical submersibles launched in 1971, is based in San Diego, Calif., and under the control of Submarine Group One. The Sea Cliff's dive is not a record. On Jan. 23, 1960, the U.S. research submersible Trieste II descended to 35,820 feet — 6.7 miles — into the Mariana Trench, at a point 250 miles southwest of Guam in the Pacific.

SEA CLIFF (DSV-4) Reaches New Diving Depths

The Navy deep-diving manned-submersible vehicle, SEA CLIFF (DSV-4), has undergone extensive modifications to extend its operating depth from 6,500 to 20,000 feet (almost four miles), while still retaining its present work effectiveness and performance characteristics. Many of the technical advances of the Navy Deep Ocean Technology Programs sponsored by the Naval Sea Systems Command (NAVSEA 05R) and developed at the David Taylor Naval Ship Research and Development Center (DTNSRDC) were instrumental in achieving this extended operational depth capability. The components and subsystems developed at DTNSRDC include the following: titanium alloy pressure hull (7-foot diameter sphere 2.9 inches thick) and ballast tankage, buoyancy materials (15,000 pounds of man-rated 34 pounds per cubic foot syntactic foam), electric drive systems, electric motors and power distribution system components, and a direct pumping, seawater, variable-ballast system, which allows the submersible to maintain neutral buoyancy for a range of vehicle contractions resulting from ocean pressure.

SEA CLIFF

The DSV-4 is 31 feet long overall, weighs approximately 60,000 pounds (30 tons) and dives with a pilot, co-pilot/engineer and observer aboard. Sea trials were conducted off the coast of San Diego, California, in April 1984, concluding with a deep dive to 15,000 feet. This achievement completed the first phase of the certification process, which allows SEA CLIFF to be certified for use by naval personnel up to the limit of the deep dive. Phase two in the process will culminate in a deep dive to 20,000 feet.

Recently, SEA CLIFF was used successfully in a major salvage operation of wreckage from a Navy/Marine Corps helicopter crash.

NACOA's new Vice Chairman will be **John E. Bennett,** retired Navy Captain and former director of the Navy's Deep Submergence Program. From 1966-1970 Bennett directed the Lockheed Ocean Laboratory in San Diego. In 1970 then Governor Ronald Reagan appointed him director of the Department of Navigation and Ocean Development. Bennett joined the Scripps Institution of Oceanography in 1974 and later formed his own company and acted as a consultant.

January 23rd marked the 25th anniversary of the record-breaking deep sea dive of the bathyscaph, *Trieste*. When Lt. **Don Walsh** and Jacques Piccard (winner, 1981 Compass International Award) went to the bottom of the Challenger Deep of the Marianas Trench in the Pacific Ocean on January 23, 1960, they set a depth record of 35,800 feet that can never be broken, as a deeper hole doesn't exist. Festivities were held in Lucerne, Switzerland and among the many attendees were MTS members **Andreas Rechnitzer** and **Larry Shumaker,** both key team members of the project.

Speaking of **Andy Rechnitzer,** on 1 March he retired as Technical Adviser to the Oceanographer of the Navy and left for the warmer shores of California.

SUBMERSIBLE NEWS AND VIEWS

from IRENE FAGER

I got a fantastic letter from Mr. Phil Nuytten, President of Can-Dive Services, in which he says that their newest sub, DEEP ROVER, is nearing completion and is due for launch and sea trials about the end of April. DEEP ROVER was designed by Graham Hawkes(WASP, MANTIS, & BANDIT) and is fitted with Hawkes' sensory feedback manipulators.

Mr. Nuytten also says that due to the interest in the DEEP ROVER (their Underwater Helicopter) they hope to build several more in their Dartmouth plant over the next year or so.

More Can-Dive news...Their latest ROVs, HAIDA 1 and HAIDA 2 are working in Senegal, Africa. SEA OTTER was completely refurbished last year with all new wiring, penetrators, manipulator, etc. Most of the work was done by ex-HYCO guys. WASP 1 was retired from active service last month and shipped to the College of Oceaneering in Wilmington,CA to be used in training.

Work is continuing on Mr. Nuytten's pet project, the NEWTSUIT, a lightweight, intermediate depth ADS rated at 750'. It is kind of a "hard" wet suit.

Lastly, Mr. Nuytten clues us in on the Perry PC-8 being used in Jamaica. He says the pilot is Phil Janca.

Great Britain's new seabed operations ship , the H.M.S. CHALLENGER, was commissioned last month. She is capable of deploying divers, manned or unmanned submersibles, TV monitors, has a decompression chamber and a "moon pool" through which diving bells are lowered. Tests and trials will take about 2 years. Address to contact the ship is...H.M.S. CHALLENGER, B.F.P.O.(SHIPS), London, England.

ALVIN dive statistics for 1984

Total dives	174
Total depth	397,704 meters 1,304,800 feet
Average depth per dive	2285.66 meters 7499.90 feet
Total time submerged	1294.01 hours
Average time submerged per dive	7.44 hours
Total passengers	326
Dives for geology	72
Dives for biology	48
Dives for test & training	1
Dives for inspection, survey, etc	9
Dives for chemistry	28
Dives for equipment tests	5
Dives for VIP orientation	1
Dives for vent dynamics	10

TOTALS 1964 THROUGH 1984

Total dives	1502
Total depth	2,480,930 meters 8,139,517 feet
Average depth per dive	1651.70 meters 5419.10 feet
Total time submerged	8907.00 hours
Average time submerged per dive	5.93 hours
Total passengers	2458
Dives for geology	476
Dives for biology	431
Dives for test & training	176
Dives for inspection, survey, etc.	119
Dives for VIP & scientist orientation	68
Dives for engineering & equipment tests	27
Dives for chemistry & geo-chemistry	68
Dives for geo-physics & vent dynamics	29
Dives for USNUSL tests & survey	14
Dives for misc. oceanography & ALNAV	73
Dives for dump site survey & recovery	13
Dives for PR purposes	8

Ed Bland writes that the ALVIN was back in the Galapagos as of March 13th for about 20 dives on the original hot water vents in an area they call the "Rose Garden". After this dive series they will make port in Panama. From Panama they will do a short biology series in the Panama Basin and then go to Puntarenas, Costa Rica. After Puntarenas they will have a total of 7 Mexican port calls before returning to Panama in mid-October. Ed will take unlimited numbers of Mexican stamped covers and also more with Panama. Ed says not many people have responded with the foreign stamped covers. Don't forget that these will be the ONLY covers from ALVIN this year.

A NEW SUBMARINE FOR RESEARCH SUBMERSIBLES LIMITED

Research Submersibles Limited

Research Submersibles Ltd. of Georgetown, Grand Cayman, recently announced the addition of P-5 (Pisces Five), a -6600 ft (2012m) deep diving submarine to its lease fleet of manned submersibles. P 5, a 3-man observation submarine, built by HYCO in 1973, underwent a complete refit in 1983. There are three viewports in the forward pilot's sphere and the submersible is equipped with two manipulators and a SubSea underwater TV system. Following the trend of ROV operations, RSL is leasing their manned submersibles with a crews, spares, manipulators, and photographic equipment, but without support ships, at the roughly the same charter rates as their unmanned counterparts. At present, P-5 is targeted for use in marine research but RSL Director, R. Janca said the company was also studing proposals to put this vehicle into commercial application in the future. For specifications and more information: RSL, P.O. BOX 1014, Grand Cayman, B.W.I.

Mrs Dan Fager
One Half Fathom Club
4004 Bay to Bay Blvd.
Tampa, FL 33629

Dear Mrs Fager,

Enclosed, please find a press release on the latest addition to our group of manned submersibles. I have also included some information regarding our educational tourism programme now in operation in the Turks and Caicos Islands. It would present an ideal opportunity for Half Fathom Club members to actually go on a submarine dive themselves and cancel their own covers. Be advised that the airfares, roundtrip to Providenciales from Miami are presently $217.00 US excursion on Cayman Airways.

We hope to see you soon!

Research Submersibles Limited
P.O. Box 1014, George Town
Grand Cayman, British West Indies
Tel: 809 949 3870 Telex: CP 4210

RSL SUBMARINE PROGRAMME - DAILY SCHEDULE

RESEARCH SUBMERSIBLES LTD. is offering the unique opportunity to participate in a submarine mission in one of our Perry Submersibles.

One day of your visit to Providenciales in the Turks and Caicos Islands can be dedicated to learning about the submarine and actually serving as a crew member on a dive in PC 1802.

Submarine dives will take place most days of the week - weather variations are not a major consideration as we will be under the waves! The narrow island shelf that surrounds the eastern end of Provo allows easy access to the coral reefs throughout their depth range and beyond. The majority of the missions being to a depth of 400-1000 feet, with a crew members experiencing a wide range of depths during the dive.

The day begins at 0800 with a slide presentation on the geologic formations of the coral reefs and the marine life which one will encounter while exploring Provo's reefs at depth. This will be followed by a briefing on the operation of the submarine: its multiple safety and communications systems, manipulator arm and photographic apparatus.

The first dive will be at 0930. The pilot and 3 crew members will motor out to the dive site in a zodiac (just outside the reef). After a complete systems check the tow boat will release the sub on command and it will submerge to 30 feet for a buoyancy test. After the underwater communications have been checked, the sub will request "Permission to Dive". On that command, it will leave 30 feet and cruise under main motor power to the 150' level where the underwater cliffs (walls) begin. Gently gliding down the face of the reef, the observation lights will be illuminated around the 250' mark and the cabin lights dimmed. All occupants will have a feeling of sharing an incredible, once in a lifetime experience as they descend down the face of the deep fore reef. Other participants in the day's activities are welcome to ride along in the tow boat to watch the descent of the submarine.

The crew will be engaged in the aquisition of photographic or oceanographic data on each mission. All members will be expected to assist in the pre-planned mission activities. Aspects of the dive will be recorded in the pilot's log, a copy of which will be available to the crew who participated on the dive.

Crew changes are made approximately every 1 - 2 hours, depending on the type of dive planned. These will be made as quickly as possible to allow everyone the maximum amount of dive time. No previous diving experience is required for crew members and children over eight years are wecome.

SUBMARINE PROGRAMME DIVE RATES

Submarine dive to 400 feet	US $ 125.00
Submarine dive to 1000 feet	200.00

These prices are all inclusive of audio/visual presentation on deep coral reef ecology, submarine safety and communications systems demonstration, T-shirt and certificate. Video tapes of the individuals dives will be available after May 1985 for purchase as will additional slides and photographs.

RSL 1/85

LEASE OR BUY ABS CLASSED MANNED SUBMARINES

RECENT OVERHAUL — DIVE READY
FROM $1000.00 PER DAY
800 - 1000 - 1200 FSW DEPTH RATINGS
OBSERVATION / DIVER LOCK OUT

PERRY PC8-B, PC1204, PC1205, PC1802
WITH OR WITHOUT PILOTS AND
SUPPORT PERSONNEL

CONTACT:
ROBYN JANCA
P.O. BOX 709
GEORGETOWN, CAYMAN BWI
TELEX: CP4389

RESEARCH SUBMERSIBLES LTD

5/80

New Life for "Discarded Vehicles"?

North Sea Submersibles Converted to Serve Science

By Robyn Janca
Research Submersibles Limited
Georgetown, Grand Cayman, BWI

Robyn Janca is one of the founders and a working director of Research Submersibles Ltd., Georgetown, Grand Cayman, British West Indies. She holds a BA from Queen's University in Canada, a BSc. in archaeology from University College in Cardiff Wales, and is currently an MA candidate at Texas A&M University studying nautical archaeology. During the past four years, she has served both as a research associate and as administrative coordinator for the Institute of Nautical Archaeology's projects in Jamaica.

During the past four years, manned submersibles have all but disappeared from service in the North Sea oil fields primarily due to the rapid development of remotely operated vehicles (ROVs). With the large range of extremely affordable ROVs being introduced each year, offshore contractors have found them more cost-effective to operate and maintain than their manned counterparts.

If this rapid change-over to ROVs has signalled that the days of operating manned submersibles for routine pipeline inspection, platform support and survey work in the commercial sector are in fact over, are these sophisticated vehicles doomed to collect dust in dimly lit warehouses alongside the wharfs in Scotland and Norway?

Until recently, it appeared that this would indeed be their fate. However, an energetic group with a solid background in submersibles and marine sciences has joined forces to form a company that may in fact breathe new life into some of these discarded vehicles that were so instrumental in the exploration and development of the North Sea.

Background History

The primary objective of this new company—Research Submersibles Limited (RSL)—is to offer the services of a submersible to the scientific research markets at reduced rates, thereby allowing scientists to conduct more research for less and still ensure a respectable profit margin for the company itself. Based in Georgetown, Grand Cayman, British West Indies, RSL has three Perry submarines—*PC 8-B, PC 1205* and *PC 1802*—and a small staff of veteran North Sea personnel, former Perry engineers and marine scientists.

The concept of the group is to purchase some of the older, but proven submersibles that are surplus to the North Sea service contractors, refit them for science, and operate them from shore-based facilities situated close to deep water. Small outboard boats would be utilized as tow boats and then would remain on station for communication and weather checks. This mode of operations would eliminate the enormous costs involved in purchasing and operating a large surface ship and enable RSL to offer the services of manned vehicles at roughly the same day rates as an ROV.

The idea behind RSL's operations stemmed from a research project conducted in 1972 by some members of RSL at the Discovery Bay Marine Laboratory on the north coast of Jamaica, in which a small submersible, *Nekton Gamma*, was operated in exactly this manner. The tantalizing data retrieved during this six-week study received preliminary discussion in a group of papers resulting from the work of Drs. L.S. Land, J. Lang, *et al.*, who described the near-vertical submarine cliff, between 55 and 130 meters and cut during the Pleistocene glaciers, that is veneered with Holocene reef growth.

The group found that the coral reefs in the area are dominated with *Agaricia* spp. near the top of the cliff, giving way to sclerosponge reef by 90 meters. At the foot of these cliffs, the steep island slope begins—unconsolidated talus succeeded by a partially lithified slope which is occasionally punctuated by massive, reef-derived rocks.

Finally, the group determined that at the maximum depth range of the submersible, 305 meters, the reef-derived sediments had begun to give way to soft pelagics. This initial foray into the deep reefs of this area along the southern edge of the Caribbean Plate created a real desire among this group of scientists to have a small submarine based at the Discovery Bay facility for longer periods of time.

Unfortunately, universities and granting bodies were becoming increasingly reluctant to fund marine research projects involving the use of manned submersibles, due to the high lease costs. Because of these fiscal restraints, plans to continue re-

search on the deep reef structures in the area were temporarily abandoned. A full 11 years later, the challenge of bringing a submarine to this research facility prompted the formation of Research Submersibles Ltd. as a formal entity, with Phillip Janca serving initially as its president and submersible pilot.

In August 1983, RSL purchased its first vehicle, *PC 8-B*, a Perry Class, -800 fsw, three-man observation submarine which had been laid up since 1978 in Scotland. After 10 work days and a new set of batteries, all its systems checked out and *PC 8-B* was shipped to Jamaica. Unfortunately, as the sub passed through the United States it was detained as an item of high technology. It is interesting to note that the *PC 8* was not considered high technology 13 years ago when Perry Submarine Builders shipped it from Florida to InterSub in Marseille, France. After a two-month delay, the Kaiser Bauxite Company, which maintains a large shipping terminal in Discovery Bay, was able to transport *PC 8* to Jamaica. Kaiser has continued its support of the submarine program at the Discovery Bay Marine Lab by providing a crane and a base of operations alongside its deep-water pier.

After test dives in November 1983, *PC 8* was placed into service by the Discovery Research Bay Foundation, which had initiated a submarine research program for the groups of students and professors from U.S. and Canadian universities who visit the lab each year on field courses. The program was designed to complement their courses and introduce graduate students and scientists to the wide variety of research and educational opportunities which now could be made available to them through the use of *PC 8-B*. At an hourly rate of $175 (U.S.), students utilizing mini-grants from their departments were able to design thesis projects involving the use of *PC 8* and many of the colleges that visit the lab are also including a "submarine experience" in their field course curriculums.

"The days of manned submersible operations for science and educational tourism are just beginning and the possibilities are unlimited."

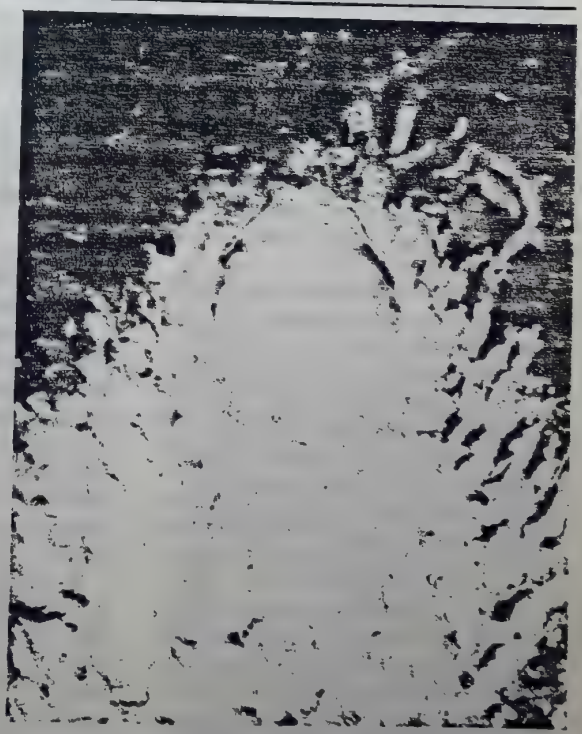
Daily Operations

Discovery Bay is a large sinkhole, approximately 2.6 kilometers square and 55 meters deep. The only entrance to the bay is through a 100-meter-wide channel. *PC 8* is launched by a 25-ton crane from Kaiser's deep-water pier and towed to a mooring just in the lee of the reef near the entrance to the channel.

Scientists or students utilizing the submarine for research projects take part in pre-dive briefings on the operation of all of *PC 8-B's* safety systems and the use of the Helle UQC through-the-water communication system and the CB surface communications. Participants are then ferried out to the submersible in an inflatable boat and, once they are transferred into *PC 8*, the chase boat tows the sub into mid-channel where the dive commences. The chase boat follows the submarine beyond the reef and remains on station to conduct radio checks every 30 minutes, keeping watch on the changing surface conditions and infrequent bauxite carriers that use the same channel.

With the warmer waters, RSL's engineers found that the batteries were supplying 10 to 12 hours of power—enough for two full days of diving. As the crane services are only provided between 8 a.m. and 4 p.m. daily and groups often request night

(Continued on page 17)



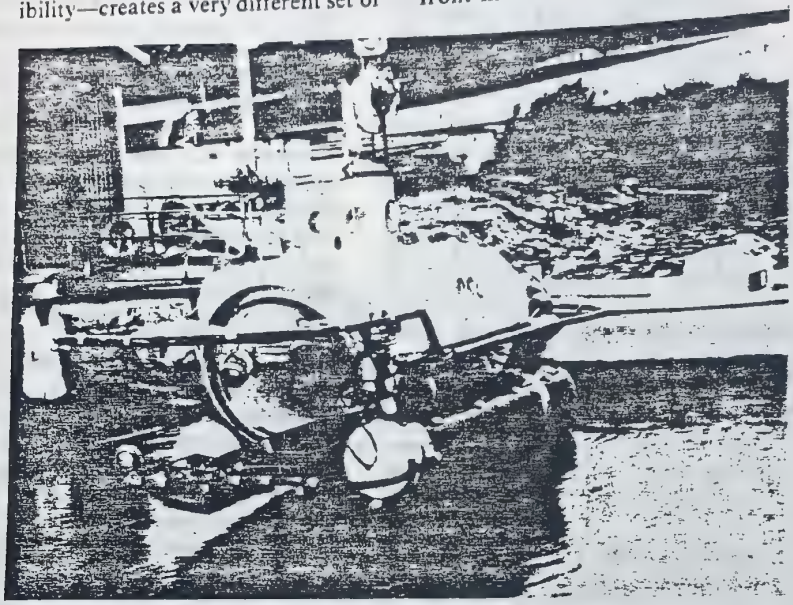
PC 8 is launched by a 25-ton crane and towed to a mooring just in the lee of the reef near the entrance to the 100-meter-wide Discovery Bay channel. Once underwater, the results often are breathtaking. This photo of barrel sponge was taken at more than 75 meters.

(Continued from page 15)

dives. *PC 8* frequently remains in the water overnight on a permanent mooring just off the marine laboratory.

Refit

Conducting scientific dives off the north coast of Jamaica—no more than 1000 meters from the reef crest and five kilometers in either direction of the entrance to the bay, in warm water with 45-meter to 60-meter visibility—creates a very different set of parameters for daily submersible operation when compared to operations in the North Sea. After nearly 100 dives in the first three months of 1984, *PC 8* was pulled out of service for a total refit.



Taken out of a five-year retirement, *PC 8-B* was given a new coat of paint, a new logo, and initiated RSL's research program for students and scientists. The submersible can operate underwater for 10 to 12 hours—enough for two full days of diving.

As all the original survey and tracking instrumentation had been removed in Scotland prior to shipment to Jamaica, the first step was to remove 13 years of yellow paint from the exterior, as well as the old discolored interior paint. After sandblasting and priming, *PC 8-B* was treated to a fresh coat of white marine epoxy and her new RSL logo. The cables were re-run and shortened and the surplus ones were removed.

The outer plexiglass protection dome that enclosed the forward 36" hemispherical viewport common to most Perry submersibles was left off after the refit. During daily operations, this dome had tended to collect sediments and encouraged the growth of algae on the main viewport by restricting the flow of water across the surface.

Two 500W and two 1000W Birns Oceanographic lights were mounted on the front of the sub, replacing three 250W lights that had been a part of the original equipment. A new six-function, 68-kilogram-capacity Perry manipulator replaced the smaller three-function, 34-kilogram-capacity manipulator on the sub. Specimen bins were attached to the front in between the lower bumper bars and the battery pods. An external bulk-loading, 35mm UMEL camera on a pan and tilt head with 150W/s UMEL strobe was fitted on the upper portion of the forward bumper bar.

The emergency breathing was revamped utilizing Sherwood regulators and new acrylic canisters were fitted to the scrubbers. Although RSL has already fitted *PC 8* with a dehumidifier, future plans call for the installation of a refrigerated air conditioning system in all the subs. For comfort's sake, the cumbersome metal-framed seats were replaced by fire-retardant contour cushions.

Scientists utilizing *PC 8-B* will now be able to return to their study sites with pin-point accuracy with the aid of a Mesotech pinger locator/interrogator system. Additionally, RSL has on-board recorders and an internal video system available to researchers.

The above modifications left several spare penetrators that can be utilized for additional instrumentation, such as current meters and thermographs. Water sampling packages, coring equipment and plankton nets can all be fitted depending on the individual requirements of the scientists.

Finally, it should be noted that researchers can also avail themselves of the Texas Instruments computer, scientific instruments, wet labs and darkrooms at the Discovery Bay Marine Laboratory.

In 1985, the main electric Reliance 7.5-hp motor, shaft and prop will be removed completely and replaced by two external 5-hp thrusters mounted on either side of the tail cone. These will act in conjuntion with the two 1-hp articulated thrusters already present on the sub and will enable the pilot to hover opposite the coral cliffs and make transects along the cliff walls and deep talus slopes at speeds slow enough to suit the scientists. It will also decrease the internal noise level and greatly add to the present 180-kilogram payload.

Future Plans

Since its refit in May, *PC 8-B* has completed 112 dive missions for a wide variety of research projects. To detail but a few:

- Dr. M. Itzkowitz of Lehigh University received funds from the National Geographic Society to study the behavior of deep-reef fishes;

- Dr. D. Liddell of Utah State used university funding to study the sedimentation and biota of the reef well utilizing photo transects and sediment traps;

- The Lerner Gray Fund of the American Museum of Natural History in New York provided a Ph.D. candidate from the University of the West Indies, Ms. C. Rosesmyth, with funding to collect and study the biology of Slit shells;

- University of Georgia botanist Dr. D. Porter has had the pilots of *PC 8* place experiments at various depths so he can study the morphology of endolithic fungi.

Prompted by its initial success in Jamaica, RSL is now in the process of expanding its services to other

(Continued on page 18)

...nds in the Caribbean which offer a sheltered shore base near deep water in an area that has abundant and varied marine resources. Availability of support services, such as cranes or marine railways, compressors, workshops and accommodation must all be taken into account.

In December 1984, RSL was scheduled to launch *PC 1802* from the Leeward Marina on the eastern end of Providenciales in the Turks and Caicos Islands. The location will afford researchers the opportunity to work along the Atlantic-Caribbean interface. Visitors to this island group will also be given the opportunity to participate on submarine dive missions as part of RSL's new educational tourism program.

In order to accommodate four observers in this -1000 fsw diver lockout submarine, RSL has modified the two aft penetrator plates into 8″ viewports. Manipulators, camera systems and a Mesotech pinger locator/interrogator system will be standard equipment in *PC 1802*.

RSL's third submarine—*PC 1205*—a -1200 fsw, four-passenger observation submersible, is currently undergoing a total refit after being laid up for four years. When launched in early 1985 from its base in Grand Cayman, *PC 1205* will be the "ultimate observation submarine for both scientists and tourists visiting the Cayman Islands," according to Phillip Janca.

Modifications to *PC 1205* include the addition of a modular 36″ spool piece in the aft section of the vehicle, which will be equipped with two 8″ viewports. The main 10-hp electric motor will be replaced by two thrusters in a fashion similar to the *PC 8-B* modifications. "Ultimately, we would like to design and fabricate a tail section which would mirror the front end of the sub, complete with a 36″ hemispherical viewport," detailed Harold Moffitt, RSL's design engineer.

In a final comment, Janca noted "that although RSL's submarines are currently at specific shore facilities, any of them could be leased to scientific groups or commercial contractors for use from either a different shore base, ship, or platform at the same economical day rates. The days of manned submersible operation for science and educational tourism are just beginning and the possibilities are unlimited." ▣

R/V SEWARD JOHNSON
Atlantic Marine

The advanced research vessel R/V Seward Johnson was delivered by Atlantic Marine, Inc. of Jacksonville to Harbor Branch Foundation of Fort Pierce, Fla. Named for pharmaceutical heir **J. Seward Johnson Sr.**, who with famed engineer and inventor **Edwin A. Link** was co-founder of the Foundation, the 176-foot ship can carry two Harbor Branch-designed submersibles capable of diving to 2,640 feet. Following completion by Atlantic Marine the vessel was taken to Fort Pierce for fitting of a specially constructed aluminum A-frame that was designed and built by Harbor Branch engineers.

The new ship is the first to be built specifically for the Foundation. Each of the other seagoing research vessels in the Harbor Branch fleet is capable of carrying a single submersible. They are the Johnson, a former Coast Guard cutter, and the 100-foot Sea Diver, originally built for underwater archeological research.

Designed by Rodney Lay & Associates of Jacksonville, the Seward Johnson has a beam of 36 feet and draft of 12 feet. The 295-grt vessel has a capacity of 60,000 gallons of fuel, giving it a range of 8,000 nautical miles at a speed of about 14 knots.

Main propulsion is provided by two Caterpillar 3512 DI diesel engines, each with an output of 850 bhp at 1,200 rpm. Electrical power is supplied by three Caterpillar/Kato diesel generators, each rated 295 kw. Two Elliot White Gill thrusters are installed, each with a thrust of 7,000 pounds, and 360-degree rotatable.

Accommodations are provided for a normal complement of seven operating crew, six submersible crew, and 10-14 scientists. A briefing room is equipped with video recorders, video monitor, projection screen, and conference table. There is also a quiet lounge with technical and science library. Laboratories include a submersible maintenance lab, submersible electronics repair lab, compressor room with dive locker, operations electronics lab, and wet and dry labs.

Navigation and communications electronics include: Sperry gyrocompass with three repeaters, autopilot, and magnetic compass; two Furuno radars; RDI collision-avoidance system; Northstar Loran with Epsco plotters and Digitac printers; Navidyne satellite navigation unit interfaced to gyro and speed log; Harris SSB transceivers; Sailor VHF; Regency Polaris VHF with ADF; Sea Lab portable radios; EDO depth recorder; Furuno depth sounder; Data Marine depth sounder; Klein side-scan sonar; Aldin weather facsimile recorder; and Dytek sea temperature recorder.

In addition to the special A-frame for submersible launch/recovery, deck machinery includes an Appleton 5-ton crane, SMATCO anchor windlass, Boston Whaler small boats, constant-tension towing winch for submersible recovery, and three capstans.

PERRY SUB IN NORTH SEA

Perry Offshore's PC 1805 submersible is installed on the Shell Expro *Stadive*. The sub, the first one to be owned by Shell Expro, is valued at £2.5 million. Shell has used manned subs before but only on contract. The PC 1805 had undergone tests especially launch and recovery through the *Stadive's* moonpool. The sub is a 4-man diver-lockout vehicle rated for 1,000 ft.

Saipem also has a PC-18 submersible on its *Ragno Due* which is operating in the North Sea. These are two of the very few manned subs at work in the North Sea today.

P.S. The *Ragno Due* also has a Fillipo ROV system installed.

Roger Cook, Director of Marine Operations of Harbor Branch Foundation, and Chairman, MTS Undersea Vehicles Committee, was seriously injured in an automobile accident in June. To update the many MTS members who have contacted MTS Headquarters concerning Roger's condition, we are thrilled to report that he is well on the road to recovery!

Dr. **Bob Jones,** Managing Director, Harbor Branch Foundation, reports Roger has improved to the point that he is able to make brief appearances at HBF. Dr. Jones stressed that not enough praise can be accorded Roger for the fine job he did in overseeing the completion of his primary task of the past year—the design and building of the 176-foot research vessel *Seward Johnson*. Dr. Jones, and all the HBF staff, regret that due to the accident Roger "had to suffer the low blow of not being able to ride his ship home and accept it on behalf of Harbor Branch Foundation."

Those Who Go Down to the Sea Are Still Using Submersibles

By Dr. Don Walsh
President
International Maritime Incorporated

Deep submersibles, manned and unmanned, have been primarily employed in support of the offshore petroleum industry. Although the world-wide economic recession and related oil glut have greatly depressed activity in offshore oil and gas development, there continues to be significant progress in the development of undersea vehicles.

This is appropriate. The timing of development and introduction of new technologies for ocean work must lead the recovery of offshore activity if they are to be in place in time.

In undersea vehicles, the major progress continues to be in the rapid evolution of the remotely operated vehicle (ROV). While the operational market is still soft (i.e., number of jobs available, oversupply of ROVs, day rates offered at distress prices, etc.), R&D and introduction of new products continue at a surprising pace. The "big four" companies that have accounted for the majority of ROVs sold to industry—International Submarine Engineering, Ltd. in Canada, and Ametek-Straza, Hydro Products and Perry Oceanographics in the U.S.—have all introduced new products in 1984. In addition, several smaller companies continue to develop new ROV designs hoping to increase their share of this expanding market. Most of these are in Europe, with one exception being a Japanese company—Mitsui Engineering and Shipbuilding—which is developing a diverse line of new ROVs.

The trend continues toward more reliable and more capable work vehicles, favoring a modular design approach to give the ROV operator maximum flexibility. The working ROV of the future will be much bigger and much more specialized. It also will be increasingly expensive to own and operate.

There is, however, another ROV trend which is evolving rapidly. This is the development of the low-cost ROV, or LCROV. At the ROV '84 Conference last May in San Diego, California, LCROVs were shown and demonstrated. With the lowest-cost ROV formerly being more than $100,000 for the basic vehicle, a price of less than $50,000 for an LCROV made quite an impression on this gathering of experts. One could sense the underlying enthusiasm for this new direction, although achieving this kind of cost breakthrough for most manufacturers would be difficult.

It is emphasized that these are not "cheap" vehicles—they are low-cost. Basically they are swimming cameras intended for inspection tasks. Nevertheless, they can accomplish a great deal of work formerly done by the more expensive systems. One LCROV —the *MiniRover* made by Deep Sea Systems International—is now on the market at about $28,000 for the basic vehicle.

At present, ISE, Ametek-Straza, Deep Ocean Technology and Bennex A/S (Norway) are all in various stages of producing LCROVs for both the old and new markets. In Japan, Mitsui Engineering and Shipbuilding has also developed an LCROV which is now being considered for quantity production.

Without a doubt, many other manufacturers of undersea systems would like to enter this field, but it will not be easy. Design requirements to build an efficient, reliable vehicle to be sold at a cost never thought possible provide real challenges. Rewards for companies who can crack this low-end market should be well worth it.

Manned Vehicle Trends

In manned vehicles, progress continues to be slow. A major trend now is the development of vehicles capable of reaching depths of 6000 meters, making 98% of the seafloor accessible to exploration. First of this "family" was the U.S. Navy's *Sea Cliff*, converted from an 1800-meter-capable submersible to a six-kilometer-capable vehicle in 1984. Second is the French government's SM-97, the *Nautile*, which also had its first test dive late in 1984. In 1985, it will conduct deep-diving operations in the Japan Trench in a joint program with Japanese scientists. Meanwhile, the Japanese government has approved the design of a six-kilometer-capable submersible which could be operational in about five years if final construction is approved. Finally, the P.P. Shirshov Institute of Oceanology of the Soviet Academy of Sciences has been planning the construction of a six-kilometer-capable submersible for several years, but there is no indication as yet that it is under construction.

More modest in depth, but more ambitious in design concept, is the *Deep Rover* submersible launched in Nova Scotia in mid-1984. This one-man vehicle, built by Deep Ocean Technology in the U.S., has a spherical plastic hull, dual manipulators and a revolutionary integrated control system. Its operating depth is one kilometer, with a safety factor of five kilometers. This writer had the pleasure of piloting *Deep Rover* on its fifth test dive.

Woods Hole's *Alvin* now has worldwide operational capability due to modification of the research vessel *Atlantis II* to a mother ship for the vehicle. While the "A II" retains most of its research ship capabilities, it now can act as a long-range support platform for *Alvin*. The conversion, completed in 1984, makes this deep-ocean research submersible even more productive.

A short summary cannot give much detail on current and projected development of deep submersible vehicles. But it can give the sense of healthy progress even at a time when research budgets are limited and offshore industry is just beginning its recovery from several bad years. /sl/

Submersible Business Holding Its Own

By John A. Pritzlaff
Program Manager, Oceanic Division
Westinghouse Electric Corporation

The past year 1984, and the new year 1985, sort of run together with respect to the deep submergence field. The construction of, and demand for manned submersible services is at a low self-sustaining level. There are numerous used or previously owned submersibles in the market place for sale or lease. New to the scene in 1984 was the recently overhauled and upgraded *Sea Cliff* of the U.S. Navy. *Trieste II* was retired in May and the new *Sea Cliff* capability to 6000 meters provides the U.S. Navy with its desired deep search and salvage asset.

Coming on the deep submersible scene in 1985 will be the French deep-diving vehicle, *SM-97*, with a capability to 6000 meters. In Japan, the Japan Marine Science and Technology Center (JAMSTEC), is working on development plans for a 6000-meter-deep submersible. Both Mitsubishi Heavy Industries and Kawasaki Heavy Industries are working on the technology developments needed for this vehicle program.

One-man atmospheric suits and submersibles continue to be in some demand. *Wasp* set a new operational depth record of 612 meters. The IUC manned/unmanned ROV *Mantis* has been in use with an interesting, if not prophetic, point. Since the vehicle can be used in either a manned or unmanned mode of operation, users have their choice of which way to go—i.e., man in the water, face to face with the work, or man on the surface face to face with a TV screen. In almost every case, users have opted for man in the water.

The picture for unmanned vehicle operations was bright in 1984 and will continue to be so in 1985. The major quantity producers—ISE (124 to date), Hydro Products (115), Straza (75), and Perry (35)—are expected to continue production of both generic and specialized vehicles to meet mainly the needs of the offshore oil community.

A new ultrasmall vehicle, *Mini Rover* (23 kilograms), was introduced by Deep Sea Systems International. Already, 15 units have been sold and reservations for 13 more have been taken.

Operator and ROV team proficiency are playing increasing roles in making vehicles perform well and in getting the job done. To this end, both Sonat Subsea Services and International Contractors are operating ROV training schools. Det Norske Veritas, the Norwegian ship classification society, is looking at various certification and test procedures for ROVs to classify them as being suitable for specific types of work, or as having one or more subsystems certified to a particular operational capability.

On the government side, the use of ROVs appears to be taking an increasing role in the mine warfare community. The use of the Westinghouse AN/AQS-14 mine hunting sonar in the Gulf of Suez and the order for 8 MNS vehicles from Hydro Products point up this need for ROVs in mine warfare defense.

Society ECA of France continues to be the leading ROV producer with some 240 *PAP 104* mine neutralization vehicles having been supplied to European (NATO) naval forces. Next summer in the U.S. there is expected to be an evaluation of the Hydro Products *ADROV* vehicle and the Gay Marine *Pluto* vehicle for possible application on ships of opportunity mine neutralization tasks. /st.

))) **Hot Vents and Exotic Animal Life Found Along Mid-Atlantic Ridge.** Hot deep-sea vents occurring along sea-bottom spreading zones were first discovered in the Pacific Ocean near the Galapagos Islands west of Ecuador. They harbored plant and animal life that live by chemosynthesis, rather than photosynthesis. Other discoveries were made in the South Pacific and in the Pacific northwest off the U.S. and Canada. Now similar vents have been found in the Gulf of Mexico and along the ridge in the Atlantic west of Dakar, Africa. Another site along the mid-Atlantic Ridge was found in 1982, 2900 kilometers east of Miami. The most recent three finds are 800 to 1600 kilometers south of the 1982 find. The discoveries were made by a research team of the National Oceanic and Atmospheric Administration (NOAA). Team scientists, using instruments and samplers attached to cables up to 3962 meters long, were able to determine water temperatures and chemical concentrations. Using cameras, the scientists identified giant clam-like forms among the rocks, the first indication that mid-Atlantic Ridge vents may have life forms similar to those observed in the Pacific. Scientists from NOAA, Cambridge University, Florida Institute of Technology, Woods Hole Oceanographic Institution and Rutgers University were embarked in the NOAA ship *Researcher*.

Artificial Gills for Undersea Powe

New Apparatus Mimics Fish's Circulatory System

By Taylor A. Pryor
Director of Research
Aquanautics Corporation

Lack of oxygen available to man underwater has always limited his ability to work there. Oxygen is present but in a dissolved state at very low concentrations and, until now, there has been no way to extract it without a very great energy penalty.

Except in the case of nuclear submarines, we have been obliged for purposes of breathing or combustion to either carry oxygen as a compressed gas or provide a hose link to the surface. For life support systems this constraint has been somewhat allowable, but for power systems the oxygen limits have been the greatest single obstacle to missions of long endurance and great depth. Unless they are nuclear, our power systems can go no deeper than the length of their cables and snorkles or no longer than the life of their batteries.

Now, at last, there is an "artificial gill" under development at the Duke University Marine Laboratory that promises to change all of this, which already is extracting oxygen from seawater in acceptable amounts with minimum energy requirement. (*Sea Technology* for January 1984, page 79, and November 1984, page 58.—*Ed.*)

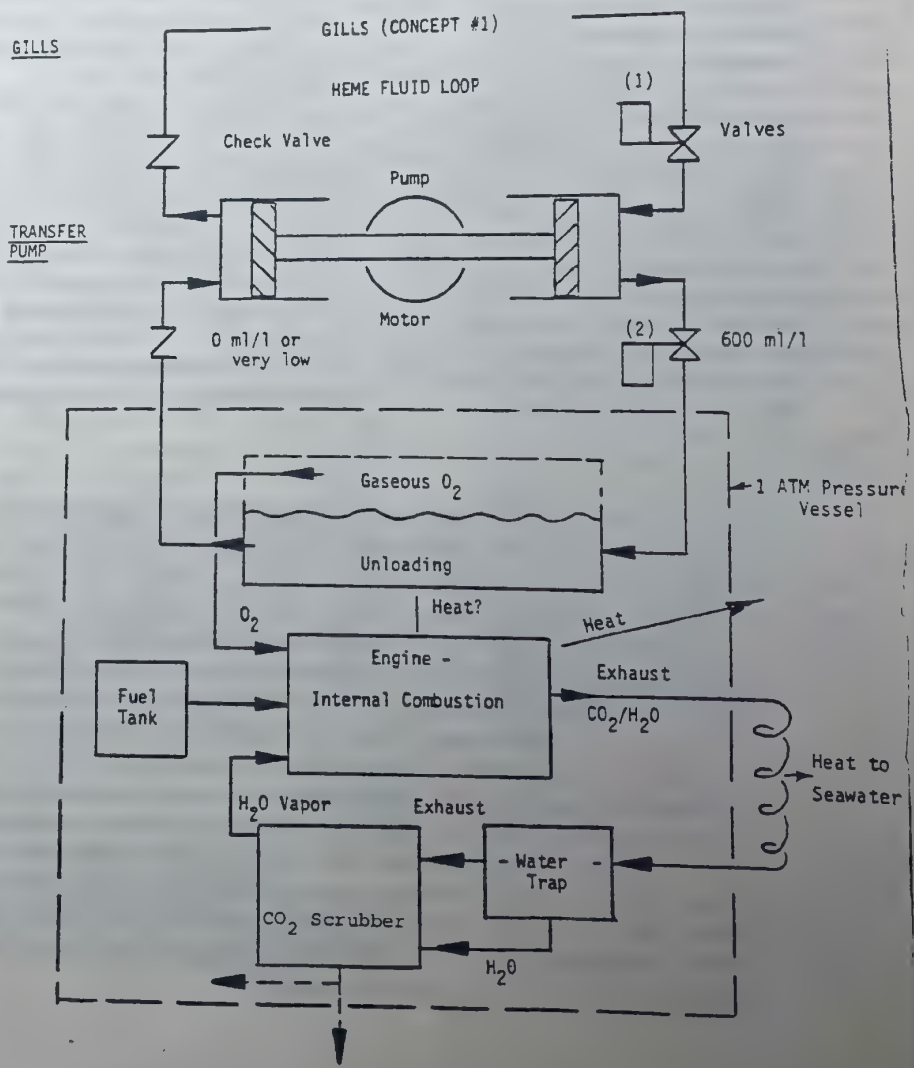
The original concept, now fully patented, was the brainchild of Dr. Joseph Bonaventura who, with his biochemist wife Celia, is co-director of Duke's Marine Biomedical Center.

The Bonaventuras have long been interested in proteins that are involved in respiration, especially hemoglobin which, in our blood and the blood of fish, provides the proper environment for reversible oxygen binding rather than oxygenation. Eight years ago, Joe reasoned that hemoglobin and other heme-like molecules could be made to bind oxygen outside of the body and that, if they could somehow be contained, enough of them concentrated would allow a diver or a submarine to mimic fish and extract oxygen from water. Typically direct, Joe extracted his own blood from a vein, separated the serum, immobilized the remainder in a polyurethane sponge and passed seawater through the sponge, noting that most of the available oxygen was extracted in passage.

With this proof of principle behind them, the Bonaventuras obtained backing from the Office of Naval Research and, subsequently, the Naval Sea Command to explore the opportunity. By 1983, they were far enough along to seek a commercial partner to assist in the funding and to focus on practical application.

Soon after, I was recruited by Aquanautics Corporation to be the director of research and, along with Drs. Joe and Celia, began assembling a team of scientists and engineers. These included Drs. Marius Brouwer and Bill Anderson from Duke University; Dr. Bruce Zenner from the University of California-Davis; Dr. Emory De Castro from the University of Cincinnati; Dr. Joe Van Ryzin, president of Makai Ocean Engineering; and Will Forman, an engineer who was formerly with the Naval Oceans System Center in San Diego, California.

By February 1984, we had put on the shelf but not discarded the "sponge" approach and began instead to design an apparatus that more closely mimics the circulatory system of a fish or a shark. In has five components: (1) a hollow fiber membrane that is exposed to seawater and that contains an oxygen carrier fluid; (2) the carrier fluid itself, which can



indeed carry hemoglobin floating like molecules in a salty environment; (3) a pump to move the fluid through the membrane to other parts of the system and back again; (4) an electrochemical unit that acts first to extract electrons from the active metal carrier, causing the carriers to lose their affinity for oxygen and later to donate electrons causing them to regain that affinity; and (5) a secondary membrane that acts to separate the now-freed oxygen from the carrier fluid so that it can be taken off in very pure gaseous form for breathing or combustion.

The initial work has been carried out in two simultaneous phases, the first in Beaufort, North Carolina, where the biochemists and electrochemists week by week have improved membranes, carrier fluids and electrochemical reactors until, on November 8, 1984, a unit that at last combined all of these was made to work as a system extracting a very few milliliters per minute from tap water.

The other phase is the engineering, largely conducted in Hawaii where Makai Ocean Engineering, under contract to Aqanautics, built a mathematical model adapting the oxygen extractor to diesel engines and fuel cells (illustrated) and then proceeded to modify a small diesel engine to accept a 30-liter-per-minute oxygen extractor for installation into an unmanned submersible.

Following the November success, Forman (in San Diego) began fabrication of a 3-liter-per-minute oxygen extractor suitable for use in air or water. The air form (which differs from the undersea form only in the size of its membranes) can be used by lung patients, miners or welders. The undersea version could be the first artificial gill, a backpack for divers.

A diver breathing pure oxygen is confined to depths of less than 9 meters but can, of course, go deeper by adding a rebreather system that scrubs the carbon dioxide and conserves a diluent gas, such as nitrogen or helium. Tests for this approach are being carried out by Dr. Richard Vann and Steve Porter, both on the staff of the F.G. Hall Hyperbaric and Hypobaric Environmental Laboratory at Duke University, Durham, North Carolina. Discussions are also underway with Phil Nuytten, president of Can-Dive, to evaluate the use of an extractor in combination with a light weight one-atmosphere diving suit that would allow divers to go to 230 meters on pure oxygen and to do so comfortably in a heated suit.

Once we have a 3-liter/minute/prototype, we expect to move rapidly on to 30 liters and then to 150 liters, the latter sufficient to provide for the combustion needs of a 15-Kw engine, all that you would ever want for an ROV and three times your need if you combine your oxygen-burning diesel or fuel cell with a battery, using one to charge the other.

In subsequent articles this year, we will discuss the full range of civilian undersea applications for oxygen extractor power packs. These include stationary and vehicular use in the offshore oil patch, for oceanographic deepsea survey work and even for subsea mining. Funding for the Duke/Aquanautics team has been renewed by the Office of Naval Research, this time sponsored by the Defense Advance Research Project Agency (DARPA). We are naturally excited by the 1985 opportunity. Each member of the team expects to breathe underwater before the year is out. More than that, we look forward to the first day when a vehicle cruises untethered for even a day without a battery or cable. /sf/

A mockup of the gill being developed by Aquanautics Corp.

National Geographic, NSF Funding Submarine Research

The National Geographic Foundation, the National Science Foundation, the American Museum of Natural History, and NESERC in Canada have funded eight separate projects to carry out research in the *PC8-B*, a three-man research submarine now based at the Discovery Bay Marine Laboratory on the north coast of Jamaica.

Individual researchers and the laboratory's Coral Reef Ecology course have booked more than 150 hours of submarine dives during the three-month summer period.

PC8-B, which was recently purchased and refitted by Research Submersibles Ltd. (RSL) of Grand Cayman, has been leased by the Discovery Bay Research Foundation for three years. The submersible, equipped with both photographic apparatus and manipulators, is operated by RSL from a shore base at the Discovery Bay Marine Laboratory.

The marine laboratory is located directly on the continental margin with immediate access to deep water and a variety of submarine environments.

Around the Pier at Scripps

by Chuck Colgan

Southern California kelp beds were severely affected by the winter storms and the El Niño of 1982-83 according to two marine biologists at Scripps. Reporting in *Science* magazine (April 20, 1984), Drs. Paul Dayton and Mia Tegner (Revelle '69) describe changes in kelp populations in the Point Loma kelp forest near San Diego Bay. The winter conditions destroyed most of the canopy of the giant kelp, *Macrocystis pyrifera*, the primary kelp harvested along the California coastline by the state's multi-million dollar kelp business. Other types of kelp, which grow well beneath the sea surface, have invaded the territory once held by the giant kelp, prohibiting successful regeneration. Some areas of the forest currently show signs of recovery, but the researchers conclude it may be years before the giant kelp is dominant again.

A multi-institutional group of marine geologists, led by Scripps graduate student Charles Paull, discovered in March unusual marine organisms in the Gulf of Mexico previously known to exist only in the eastern Pacific Ocean. While working in a three-man submersible about 200 miles off Florida at a depth of nearly 10,500 feet, the scientists found "vent" communities only known to exist at geologically active sea-floor spreading centers, where boundaries of the earth's huge crustal plates meet. The vent communities—including six-foot-long red-blooded tube worms, red-fleshed clams, white eel-like fish, and other strange animals—do not receive primary energy from the sun through photosynthesis, but rather from the chemical energy supplied by bacterial oxidation of reduced sulfur coming from the hot vent, a process called chemosynthesis. "This discovery significantly extends the range of these deep-sea communities and demonstrates that they can occur in geological settings other than spreading centers and without a heat dependence," Paull said.

A special summer study examining the shift over the next 25 years from earth-based to space-based resources for space operations will be conducted at the California Space Institute, headquartered at Scripps. Sponsored by NASA under the auspices of the American Society of Engineering Education, the program will bring to Scripps an interdisciplinary team of about 20 summer faculty fellows supported by a series of workshops involving experts from industry, universities, and government. They will explore the use of non-terrestrial materials and energy sources, transportation systems, and the processing and storage of materials in the earth-moon domain.

Marine biologist Dr. George N. Somero has been selected as the first John Dove Isaacs Chair in Natural Philosophy at UCSD. The endowed chair is named in honor of ocean pioneer John D. Isaacs, who died in 1980. Somero, a professor and chairman of the Marine Biology Research Division, will receive at least $15,000 annual income from the funds for a period of five years. Somero, a resident of Del Mar, is primarily interested in the physical and chemical adaptations that enable marine organisms to cope with their environment.

Scouting Beneath The Deep Sea

THE VOYAGE OF the USGS Research Vessel S. P. Lee, as reflected in recent dispatches from Science Correspondent Charles Petit, has implications that are as wide-ranging as the scientific antennae with which it scours the ocean deeps. She is on a 40,000-mile treasure hunt, scouting for oil, gas and mineral deposits. Discoveries by the Lee and her sister vessels probing the deeps could have extraordinary effect on the world's economy.

Take, for instance, a dredging and sampling run the Lee made last November through the Pacific's Line Islands. One seamount showed 2.5 percent cobalt in a manganese crust an inch or so thick. Cobalt, which is used for steels in jet turbine engines and armor plate, is the top prize in underwater mineral search.

THIS WAS THE richest cobalt deposit ever found, and it was only 40 miles from the limit of U.S. territorial waters.

Aside from the pure scientific importance that attaches to analysis of the stuff of the oceans, this kind of discovery surely stands as reason enough for the United States to support such exploration. And to continue to demonstrate American prowess in a vital field.

There is another issue involved here. It bears on the sovereignty of nations over these waters. President Reagan's proclamation of an exclusive economic zone within 200 nautical miles of every state or possession of the United States gives this country claim to the bounty of a staggering amount of underwater territory.

But the United States, basically because of objections to underwater mining controls, has refused to sign the Law of the Sea agreement. Somehow, sometime, America is going to have to come to terms with that treaty.

Exotic Marine Life Sighted Off Oregon

Newport, Ore.

Scientists say they had found exotic marine life surrounding hot water vents a mile below the surface of the Pacific Ocean off Oregon.

The researchers, in a tiny submarine, explored a fantastic and foreign world that contains valuable minerals and exotic marine life, including worms up to five feet long and unusual species of clams.

"The most dramatic aspect was the teeming life in the warm water vents," said Alexander Malahoff, a geophysicist with the National Oceanic and Atmospheric Administration, who led the expedition. "The worms usually have red heads, and they have these tubes that they live in, some of them are up to five feet high. So when you're driving the submarine, it's like driving through a wheat field."

The submarine Alvin, which can carry three people, operated by the Woods Hole Oceanographic Institution of Woods Hole, Mass., also transported scientists who first encountered similar formations and organisms off the Galapagos Islands in 1977. The strange life forms draw their energy from sulfur compounds in ultrahot water, not sunlight, as conventionally studied plants do in photosynthesis.

The deep-ocean process, known as chemosynthesis, begins with bacteria that feed on sulfur compounds filtered from plumes of water, which are heated by molten rock beneath the sea floor. These hot-water spots occur at the margins of huge plates of the earth's crust that are separating. Along the line there is volcanic activity.

"The effluent coming out of these vents contains what probably would be very noxious chemicals," Malahoff said in an interview aboard the Atlantis II, the Alvin's 2300-ton support ship. "But the worms and clams flourish in the poison and in fact have evolved to be able to convert it to food."

The colorful sea life was found in the crater of the 4000-foot Axial Volcano, 250 miles west of Astoria, Ore., Malahoff said. Another field of vents was found 100 miles to the north, also on the Juan de Fuca Ridge, a gigantic undersea mountain range, he said.

"We recorded the hottest water discovered on the Juan de Fuca — 293 degrees centigrade," Malahoff said. Scientists in a Canadian submarine, Pisces IV, found vents last summer in the first manned dives to the Juan de Fuca, but went neither as deep nor as far south as Alvin.

In the latest voyage, which left San Diego on July 4, Malahoff, Robert W. Embley, an oceanographer for the oceanic and atmospheric agency, and their pilot, James E. Hardiman, became the first humans to visit the Gorda Ridge, another vast undersea range off southern Oregon and northern California.

Expecting large deposits of minerals on the Gorda, the United States Minerals Management Service — an Interior Department agency — had hoped to lease mining rights to a 70,000-square-mile tract, including the ridge. But the scientists said Saturday that they found no signs there of active hydrothermal vents, which they said would indicate active mineral formation.

In Los Angeles, Reid P. Stone, an official with the Minerals Management Service, said that despite the findings, the agency intended to continue work on the lease proposal, which is the subject of a draft environmental impact statement.

Buford R. Holt, a scientist with the service, said: "The fact that they haven't found active vents doesn't mean there are no economic deposits there that formed some time in the past. The Gorda Ridge is a much slower-spreading area than the Juan de Fuca."

Iron, copper, zinc and silver were gathered this month in 10 dives to the Juan de Fuca Ridge, and more minerals may be identified in hundreds of pounds of samples brought to the surface, the scientists said.

New York Times

Mysterious Marine Life Found in Gulf of Mexico

Scientists diving off the Florida coast in the submersible *Alvin* recently came across a community of exotic marine life which has no apparent means of sustaining itself. The discovery came as researchers from the Woods Hole Oceanographic Institution were conducting geological studies of the West Florida Escarpment, a steep slope leading to the sea floor in the Gulf of Mexico.

The community is similar to the ones discovered in 1977 in the eastern Pacific Ocean. But those communities are grouped around spreading centers—the boundaries of the earth's crustal plates where new crust is formed as molten rock pushes to the surface. This biologically active area, lying in 3000-meter waters some 400 kilometers offshore Florida, sits in a passive continental margin, with water temperatures apparently no greater than the surrounding sea water. Moreover, the Pacific communities are now known to survive via chemosynthesis—a life-support system that is driven not by photosynthesis but by geothermal activity at the spreading centers—but what supports the life at the Gulf of Mexico community is as yet unknown.

According to reports from the research vessel *Atlantis II*, support vessel for *Alvin*, the community may stretch for more than 1.5 kilometers and contains large clams, mussels, crabs, fish and tube worms like those found at hydrothermal vents in the eastern Pacific. Scientists have collected specimens of some of the animals to determine whether they are similar to those found in 1977. There will also be tests to determine whether hydrogen sulfide, which supports the Pacific communities, also supports this one. If sulfide is present, the scientists will have to find where it is coming from.

NR-1 Nuclear Submersible Set To Explore Reykjanes Ridge

The U.S. Navy's only nuclear powered research submersible, *NR-1*, next summer is scheduled to conduct an exhaustive exploration of the undersea Reykjanes Ridge that stretches 770 nautical miles southwest of Iceland. Preliminary trial runs were made in the Bahamas in November.

The ridge is an elevated portion of the mid-Atlantic Ridge with some areas as shallow as 1000 meters below the surface. It holds strategic implications because the deeps on each side serve as undersea highways for Russian submarines transiting from or to the Murmansk area. A Russian proposal made in late 1980 was to hold a joint exploration expedition using the Navy-owned, Woods Hole Oceanographic Institution (WHOI) operated submersible *Alvin*. The U.S. Navy brought pressure to bear that resulted in the U.S. scientists declining the invitation. (Details in *Sea Technology* for March 1981, page 7.)

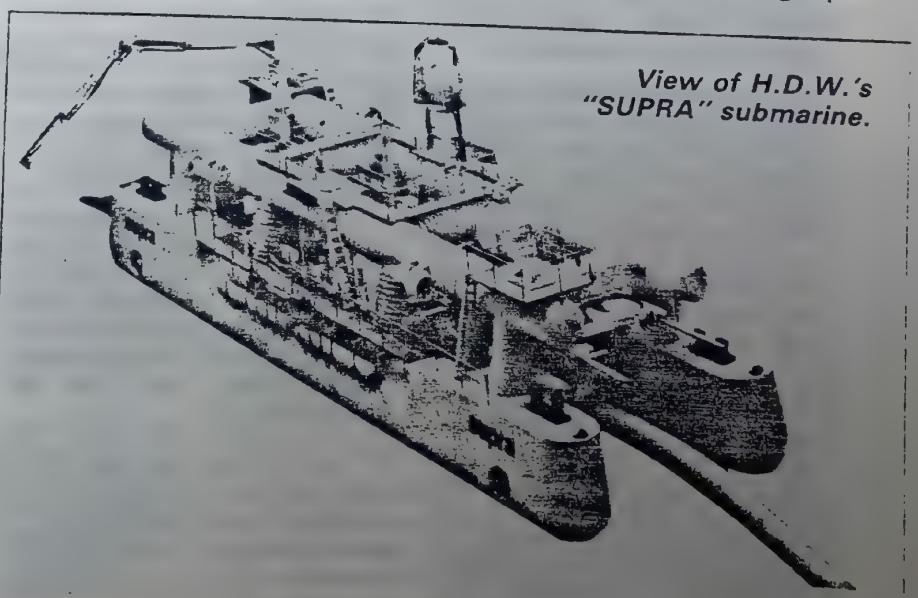
Participating in both the trials and the exploration is geologist Dr. Robert Ballard, discoverer of hot spots along the seafloor spreading mid-Atlantic Ridge and near the Galapagos Islands in the Pacific.

Howaldtswerke-Deutsche Werft: Positioning and emergency control for submarine

To insure positioning and emergency control for an innovative new submarine, the West German shipyard Howaldtswerke-Deutsche Werft (H.D.W.), located in Kiel, has acquired a complete, specialized High-Frequency Short-Baseline system from Oceano Instruments. The tethered submarine, christened "SUPRA", will rely on the two-pronged acoustics system for positioning to within +/− 25 cm and, if the supply cable fails, for transmission of control command from the surface.

Equipment ordered includes the new IM 200 Data Interface Module (see article elsewhere in this issue). H.D.W.'s version of this device provides, besides the central processing unit, a second unit capable of interfacing data from the following sources: black and white video, an external keyboard, gyro compass, depth gauge, vertical reference unit, arithmetic processor, memory enlargement, graphic display, and an HPIB.

"SUPRA" is an unusually large submersible pipeline repair and maintenance workshop, measuring approximately 34 × 12 × 7.5 meters. It eliminates the conventional but expensive and hazardous practice of raising damaged seabottom pipe to the surface for such operations. Shaped like a catamaran, it is able to take two persons down to 420 meters water depth and to straddle the section of pipe needing repair.



View of H.D.W.'s "SUPRA" submarine.

SSOS LOCKOUT SUB

Sub Sea Oil Services (SSOS) is building a new mini-sub for offshore and military diving operations. The 30 ft. long, 24 ton submerged displacement sub has a tear-drop shaped hull, which, when welding is complete, will be coated with Emerson & Cuming's ECCOFLOAT. It will be capable of diving to 2,150 ft. with lockout operations to 1,000 ft. The prototype can carry 4 unsaturated divers, pilot & copilot and a diving technician. SSOS designers say the design could be modified into a rescue sub for up to 24 people. A key technology feature in the sub will be a closed-cycle engine using a conventional diesel. A redesign of the combustion chamber will remove the carbon monoxide exhaust gas. The exhaust will also be scrubbed and cooled by passing it through water and a semipermeable membrane. In addition to the prototype, SSOS is planning a production version, as well. Both are to Det norske Veritas specifications. SSOS is a wholly owned subsidiary of Microperi, Italy.

Deepest plant found. Smithsonian scientists using a unique research submersible have discovered the deepest known plant life on an uncharted seamount (underwater island) off the northern border of San Salvador Island in the Bahamas. The totally new and as yet undescribed macroscopic (visible to the naked eye) plant—a purple, crustose coral-line alga—was discovered by Dr. Mark M. Littler and Diane S. Littler of the National Museum of Natural History. The discovery was reported in the Jan. 4, 1985, issue of Science magazine by the Littlers. Stephen M. Blair of the Harbor Branch Foundation Inc., in Ft. Pierce, Fla., and Dr. James Norris, also of the Museum of Natural History. The plant was found growing abundantly at a depth of 884 feet, some 280 feet deeper than the previously known deepest plant.

• ECCOFLOAT ED is a new, high-performance syntactic foam from Emerson & Cuming. It is designed to provide high buoyancy per unit volume in very deep water. The ED provides 28 lbs. per cu. ft. of buoyancy in sea water and can be used to a depth of 15,000 ft. It can be molded into custom shapes without cutting and gluing. ED can be sawed or machined with conventional tools and the cut surfaces do not require preparation before use. Hardware can be bolted on, strapped, bonded in place or molded into the unit. At present, ED is available in one standard density, nominally 36 lbs. per cu. ft. (0.58 g/cc). Contact E&C for further details.

LIQUID FOAM BUOYANCY

SUBETA is a liquid syntactic buoyancy material from Balmoral. It is incompressible and certain grades are capable of operating down to 8-10,000 ft. While SUBETA responds to hand pressure unidirectionally, when it is submerged and under uniform pressure, it becomes rigidly locked into its predetermined profile. The material is both pumpable and pourable and can be used for filling large structures.

SUBETA can be supplied in either neoprene or plastic prepacks of varying sizes and designed for easy attachment to other components. There are many applications for SUBETA, from salvage to buoyancy adjustment on existing equipment. Balmoral Hitec Buoyancy will work with you on most any application. Contact them at Hareness Road, Altens Industrial Estate, Aberdeen AB1 4LE, Scotland. Tel: (0224) 874052; tlx: 739779 (Balmar).

To Study Deep Seabed Mining

The certification of 4 U.S. applicants for the first deep seabed mining exploration licenses in international waters was announced by NOAA April 27.

The proposed license areas are in the northeastern equatorial Pacific Ocean—known as the Clarion-Clipperton Fracture Zone—between Central America and Hawaii. The area contains a high concentration of manganese nodules, which are small, irregular, potato-shaped concentrations of manganese and iron found on the bottom of many of the world's oceans and lakes.

The certifications were approved for Kennecott Consortium of Salt Lake City, Utah; Ocean Mining Associates of Gloucester Point, Virginia; Ocean Management, Inc., of New York City; and Ocean Minerals Company of Mountain View, California.

NOAA found the applications to be in full compliance with the Deep Seabed Hard Mineral Resources Act. The act directs NOAA to determine whether an application should be certified as an intermediate step for a deep seabed mining license.

MANNED SUB CODE OF PRACTICE

A code of practice for the operation of manned submersibles, which has been officially recognized in the United Kingdom, Norway and Canada, has just been published by the Association of Offshore Diving Contractors. It is a composite document which gives sound practical advice on all aspects of the operation of manned submersibles.

The preface of the 139-page document states clearly the legal basis of the code: Submersibles began to be used commercially in support of offshore activities in the late 1960s and since then various types have been successfully developed ranging from tethered, one-man vehicles to untethered vehicles having a pilot and crew and sometimes a diver lock-out capability. There are now over 100 manned submersibles on the commercial market and they are being operated successfully in many parts of the world.

As the industry expanded, several organizations and societies developed guidance notes and rules or standards on the operation of submersibles until, in 1979, the Marine Technology Society (MTS) published a book entitled *The International Safety Standard Guidelines for the Operation of Undersea Vehicles.* This has been widely used across the industry by designers, manufacturers and operators of submersibles as well as by government departments.

As the organization representing the interests of manned submersible operators, the Association of Offshore Diving Contractors (AODC) decided that an up-to-date "Code of Practice" should be produced for the operation of all types of manned submersible craft. The code has been designed to harmonize safe operating practices throughout the industry, not only for existing operators but also for new companies in the field.

The code has been produced by the AODC's Submersible Committee with the support of contractors, manufacturers, clients, Government departments and other agencies. The UK and Norwegian governments both contributed significantly, by way of advice, during its preparation. Work on the code started in 1981 and a large number of organizations were given the opportunity to comment on a final draft. Despite its formal recognition in three countries, the code is not geographically limited in its scope and should be applicable in all areas of the world where commercial submersible operations are carried out, particularly in support of offshore hydrocarbon exploration and production.

The code is divided into seven sections dealing with personnel, operational planning, operational procedures, emergency planning, emergency procedures, equipment and a special section on maintenance procedures, back-up requirements and industry abbreviations. It covers all types of manned submersible craft— both present and planned— whether freeswimming, tethered or autonomous. Considerable emphasis has been placed on the handling of emergencies.

Draft regulations are currently being considered in Norway but the new code has already been recognized for use in offshore work in that country.

The Code of Practice for the Operation of Manned Submersible Craft can be obtained from the Association of Offshore Diving Contractors, 28/30 Little Russell Street, London WC1A 2HN. Tel: 01-405 7045. Priced £60 to non-AODC members.

AODC has also published four new log books to add to its now-familiar standard Divers log book. They are: The Inspection Diver's; the Diving Supervisor's; the Submersible Pilot's; and the Life Support Technician's log books. They cost £6 each plus tax and overseas postage.

American search team recently located the *Leopoldville*, which sank in World War II.

High Tech Hunts Sunken Treasure

THE DISCOVERY this summer of a rich array of sunken mystery ships—possibly including a long-sought French freighter laden with gold—heralds a new era in underwater exploration.

That's the prediction of a nonprofit research group, the National Underwater and Marine Agency (NUMA), which has just completed an extraordinary season of discoveries, including—

- The *Leopoldville,* a steamship carrying 2,200 American soldiers that was torpedoed by a German submarine off Cherbourg, France, on Christmas Eve, 1944. About 800 GI's were killed, and many are still entombed in the vessel.
- The *U-20,* a German submarine rediscovered off the Danish coast. It sank the luxury liner *Lusitania*—an action that helped plunge the United States into World War I.
- A freighter off Weymouth, England, that may be the *Montclair,* a vessel believed to have spirited a fortune in gold out of France when the Germans took control in 1940.

Although divers have probed for wrecks for centuries, the spate of recent discoveries from Europe to the Chesapeake Bay reflects the best success to date. Many findings were made by devices such as side-scan sonar, which beams sound to the sea floor and converts echoes to pictures, and by computers and satellites that pinpoint sites.

New technology also is being used to process valuable discoveries. Example: A new chemical, Fomblin, is preserving materials in the sunken liner *Andrea Doria's* safe, which was salvaged in 1981. The safe was opened August 16 after a three-year delay.

Clive Cussler, who founded NUMA to search for historic vessels, says the freighter matching the *Montclair's* description was spotted by new testing equipment aboard the organization's leased yacht, the *Arvor.* Because NUMA does not hunt treasure, sonar pictures of the sunken ship and its location were given to British authorities for further exploration.

Ironically, it was the use of such equipment that got NUMA into trouble while the *Arvor* was searching off the coast of France for the *Leopoldville.* Cussler says that the vessel lies "right in the middle of the French Navy's nuclear-testing grounds. Who shows up but Clive Cussler and his merry band, on this boat loaded with underwater detection gear. The French must have thought we were the Central Intelligence Agency."

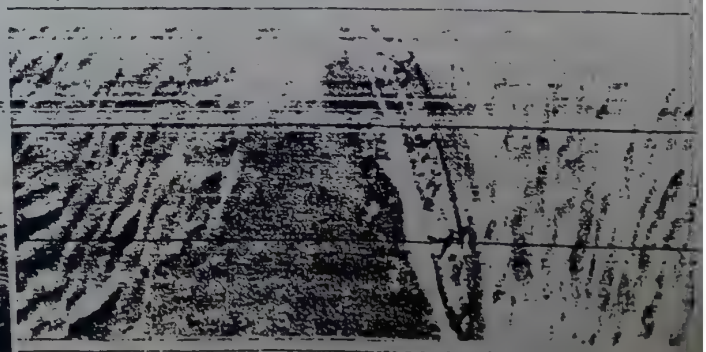
French officials, he says, "tore our boat apart." Cussler's search request was turned down, and the *Arvor* was forced to depart for England. En route, it made a quick pass over the area where the *Leopoldville* was supposed to be and quickly located the wreck. With the French threatening, the *Arvor* scurried to safety in British waters.

Memorial plans. The *Leopoldville,* about which little was ever made public, turned out to be a major find. The ship had been sought for years, and now there are plans to create a memorial near the vessel.

Cussler says that hundreds of lives were needlessly lost in a blundered rescue attempt. "The Army," he says, "sent out telegrams to hundreds of relatives of those men that said only, 'Killed in action.' Many relatives still have no idea where or how those men died."

Other results from recent discoveries, including a probe of the U-boat, will take longer to assess. But already, scholars say, the research shows that there is much more treasure to mine than gold —and that new technology promises even more rewards in the future. □

BILL SHEA—BRANDEIS UNIVERSITY



Research ship *Arvor* probes ocean bottom. On one sweep, sensors detected wreck that may be gold-laden *Montclair.*

Titanic's secrets

A Texas oil millionaire announced yesterday that he plans to dive on the wreck of the Titanic and uncover its highly-valuable secrets.

Jack Grimm (58) believes he has located the luxury liner 1200 feet down in the Atlantic 800 miles off the coast of Newfoundland and next summer he will spend a million dollars to find out if he is right.

Using an eight-man submarine lent by the U.S. Defence Department and a 40-man surface crew, he plans to dive on the wreck and enter the ship through the massive gash made by the fateful iceberg.

In the purser's office he believes he will find diamonds, gold and other valuables, including a jewel-encrusted edition of the "Rubaiyat of Omar Khayyam." The possible haul has been estimated at £250,000,000.

Mr Grimm's four-year search for the ocean liner is described in his book "Beyond Reach: The Search For The Titanic," which is to be published next week.

Video film

His publisher said yesterday, "He has taken a video film at the site which shows the ship's propeller fairly clearly."

If the expedition is successful it is thought there could be lengthy legal battles to establish ownership of anything recovered.

"For Mr Grimm the challenge is doing something which until recently was regarded as quite impossible," added his publisher.

"He is a very wealthy man and it is the challenge, not the lure of money, which has motivated him.

No refloating

"If he finds the Titanic he has no plans to refloat it.

"He says that, according to the information he has, the gash in its side is so large that to undertake a salvage operation to refloat it would cost at least 100 million dollars.

"It's an option he looked at but has now discarded."

Mr Grimm has previously launched unsuccessful searches for the Loch Ness monster and Noah's Ark and in the autumn heads an expedition to seek the lost city of Atlantis.

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Underwater Robots for Submarine Rescue

A series of trials carried out by Sub Sea Surveys Ltd for the Ministry of Defence (Navy) has established the feasibility of using a commercial remotely operated underwater vehicle (ROV) to assist in the rescue of a sunken submarine.

At present the rescue of trapped personnel from a Naval submarine in shallow water uses the well-proven individual 'free ascent' from the vessel's escape hatch.

For deep water, such systems as the US Navy 'Deep Submarine Rescue Vehicle' or the commercial 'British Oceanics' diver lock-out submersibles may be used. However, there still remains the consideration of maintaining life support whilst the rescue vehicle arrives on site, which in the worst case may be up to three and a half days. During this time it could be of considerable assistance for supplies and life support equipment to be delivered to the stricken submarine.

Remotely Operated Underwater Vehicles are used commercially by the Offshore Oil Companies and about 100 of the larger units are in operation worldwide. Suitably modified it is possible that they could be used to 'deliver' life support supplies to a trapped submarine.

In the recent Royal Navy/Sub Sea Surveys trials, the ROV was successfully used to locate a Royal Navy submarine positioned on the seabed off the coast of Scotland. The cable-controlled vehicle then used its television cameras to carry out an inspection of the submarine's hull.

Using its manipulator the ROV was able to deliver rescue equipment to the submarine, including 'posting' of life support containers through the submarine's escape hatch to the crew inside using a specially constructed handling system on the ROV.

In the final phase of the programme the ROV was used to observe a dummy 'escape' from the submarine.

The ROV was tracked from its support vessel by use of a 'Super Short Baseline' underwater tracking system, the results being fed into a Sub Sea Surveys computer system, which uses in-house designed software to produce a real time graphic display showing the positions of the Royal Navy's submarine; the ROV support vessel and the ROV.

Divers Search Out Secrets of the Past And Pirate Gold

New York

A galleon with $2 billion in treasure ... an ancient Roman sailboat that may have crossed the Atlantic. .,. a craft that dates from the very beginning of sea travel ...

The Earth's oceans, seas and lakes conceal thousands of shipwrecks. Some, such as the Lusitania, have been stripped clean, and others, like the Titanic, have not even been found. But as a group they contain billions in gold, silver and artifacts, along with an equally rich store of answers to ancient historical puzzles.

The most recent epidemic of treasure fever dates back to 1937, when Art McKee found a single Spanish coin dated 1721 in a shipwreck off the coast of Florida. After scuba gear and underwater detection equipment were developed in World War II, treasure hunting grew as a hobby — and an obsession.

In 1964, divers found 2500 gold doubloons worth more than $1 million on the ocean floor off Vero Beach, Fla. Then came two big, multimillion-dollar finds: the Spanish galleon Maravillas in 1972 in the Bahamas and the galleon Concepcion in 1979 off the Dominican Republic.

The king of the treasure hunters is Mel Fisher, who has salvaged more than $50 million from the galleons Atocha and Marguerita and is still looking for $500 million he says they spilled on the ocean floor.

New treasure finds have been reported this year. A Martha's Vineyard man says he has found the Whidah, a pirate ship carrying gold and silver that sank near Cape Cod in 1717. Last month, treasure hunters said sonar readings had located the De Braak, a British ship laden with jewels, gold bars and silver that sunk in 1798 two miles off the coast of Delaware.

But the world's biggest treasure hunt is taking place in Colombia, where the San Jose, a galleon that sank in 1708, is thought to be sitting in 700 to 1200 feet of water. With an estimated $2 billion in gold aboard, the San Jose is regarded by treasure divers as the world's greatest undiscovered wreck.

Most galleons were blown by storms onto beaches or reefs, where they were easily salvaged. But the San Jose sank quickly in deep water after a cannonball from a British warship hit her gunpowder storehouse. So far, salvagers have spent millions of dollars and more than five years in their search.

If the San Jose is the deep's richest treasure, the Titanic is its most famous. Millionaire Jack Grimm led expeditions in 1980, 1981 and 1983 to try to find the luxury liner on the bottom of the Atlantic.

Another Titanic search team is scheduled to leave next summer from the Wood's Hole Oceanographic Institution in Massachusetts. National Geographic's Emory Kristof, the expedition photographer, said it will have more time, a bigger boat and better equipment than Grimm's parties.

Although the Titanic was rumored to have a fortune in jewelry aboard, its primary value is its celebrity. Collectors pay $1000 for a German U-boat periscope lens; what would they pay for a Titanic life preserver?

For historians and marine archeologists, shipwrecks are a different kind of treasure. When divers found the 1864 steamer Bertrand in the Missouri River, they gained a window on the past — the boat was carrying a year's supplies for a general store in Montana.

"Any well-preserved wreck is a time capsule," said Clive Cussler, a novelist and shipwreck hunter who raised the huge bronze bell of the Union warship Cumberland in 1981 from Virginia's James River.

Robert Marx, the treasure hunter who found the Maravillas in 1972, has discovered fragments of pottery storage jars used on ancient Roman ships on a reef outside Rio de Janeiro.

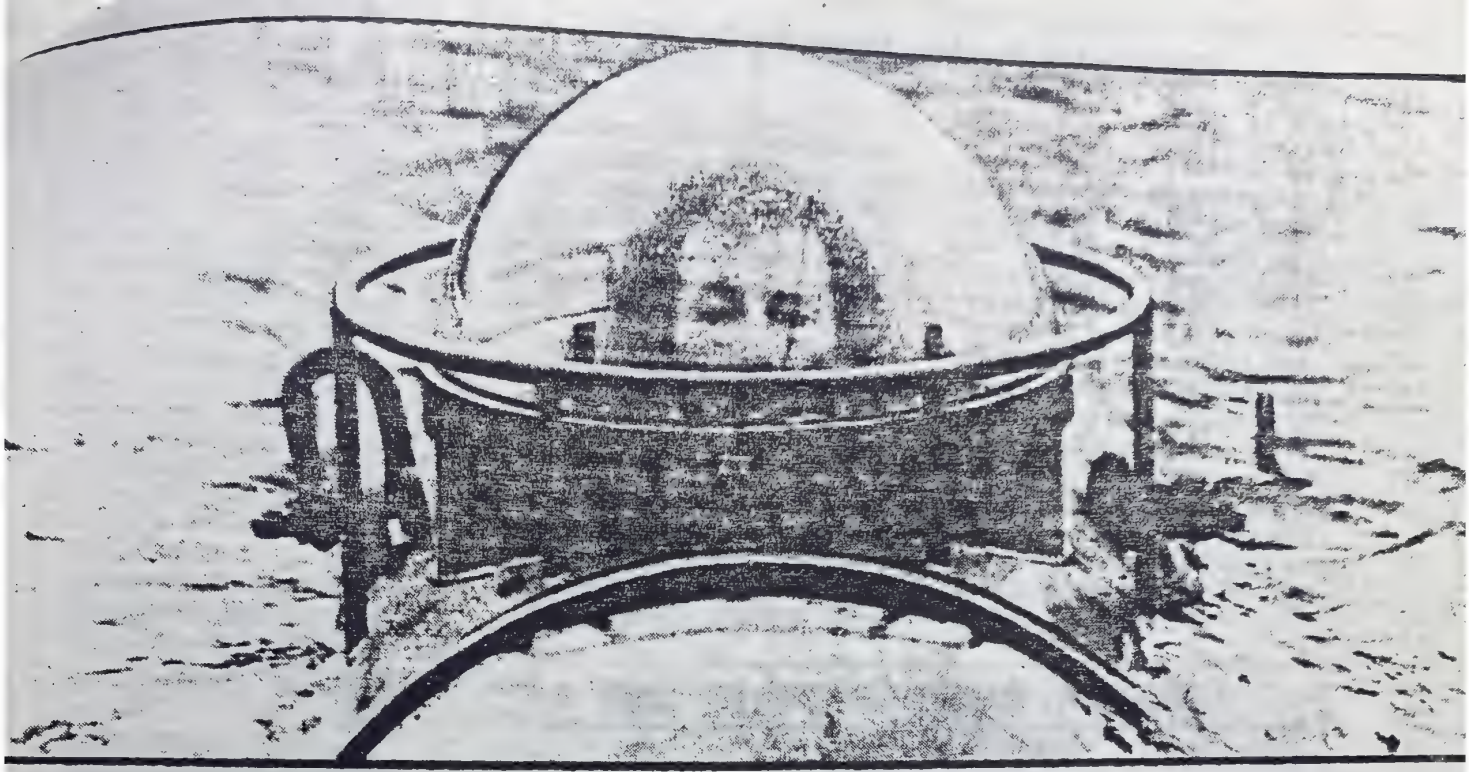
Marx said his attempts to find the ship itself have been frustrated by the Brazilian government, but Harvard marine archeologist Peter Throckmorton called Marx's find "the most dynamite discovery" since the first evidence of Viking settlements in North America.

Last year, a Bronze Age vessel that may be more than 3000 years old was discovered off the Mediterranean coast of Turkey. This summer, a team led by George Bass, director of the Institute of Nautical Archeology in Texas, worked on the wreck, the oldest ever found underwater.

So far, the institute has revealed little about the expedition's findings, other than to say that they will shed light on man's first attempts at sea trade and travel. Among the artifacts recovered are copper ingots in the shape of ox hides.

For researchers, wrecks like these are "a dream come true," said Derek Goodwin, a journalist and diver. "They can write history on a blank page."

Divers also are trying to reach a variety of other wrecks: the ship that chased down the Bounty mutineers before sinking on the Great Barrier Reef off Australia; the Napoleonic fleet that Lord Nelson sank near Alexandria, Egypt; the ships the British commander Cornwallis scuttled before his surrender at Yorktown to end the Revolutionary War.

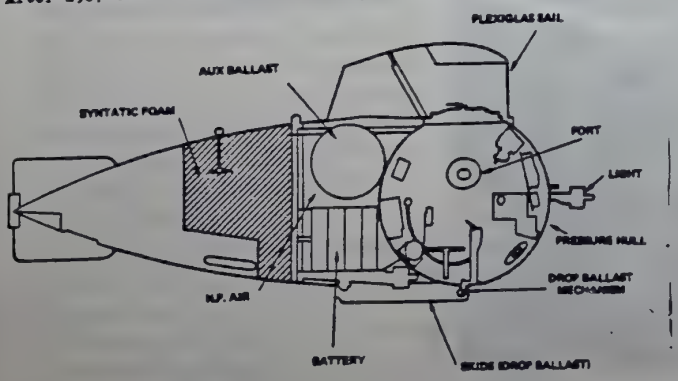


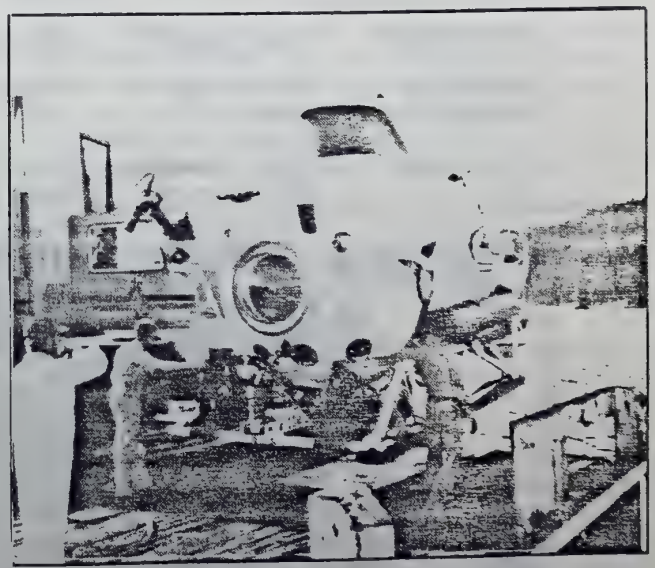
Homemade submarine

Ned Jago, 47, designer-builder of the 7-foot, 6-inch by 5-foot, one-ton battery driven steel submarine floating in Axmouth, England, harbor, said after successful diving and resurfacing trials, "That was smashing. It was a piece of cake and it went like a dream. It was comfortable and stable and best of all there were no leaks. (AP Photo)

ASHERAH

Launched May 28,1964 the ASHERAH was built for the University of Pennsylvania Museum to be used for underwater archaeology. Funded by the National Geographic Society and the National Science Foundation, it was originally under use by George Bass at the Museum.
Capable of 600ft. dives (1200ft. collapse) it was a two-man sub. At its launching it was named ASHERAH after the Phoenician goddess of the sea. There have been reports of covers for its dives in Turkey in 1964 and in Hawaii in 1965 on biological research. What is not clear is that during the interim period between its launching and post-1966 operations, it was referred to as the STAR II by its pilots and on covers.
The cover shown for one of its 1966 dives off of California illustrates the first use in a cachet of the name ASHERAH. These west coast dives also were at its depth limits.
The second cover illustrated is for one of its 1967 dives at Yassi Ada, Turkey to investigate a 1400yr. old shipwreck. Piloted by the Turkish commissioner Yuksel Egdemir it made several dives to study and photograph the wreckage. This phase of its operations can be read about in the Sept. 1968 National Geographic. The article makes it appear that it is a new tool just built, although as mentioned above, it dove in Turkey 3 yrs. earlier. After 1967 the submersible did not dive again.





The Canadian Forces SDL-1 submersible on sea trials subsequent to a recent modernization at ISE. It is interesting that the test pilots were **Mike Macdonald** and **Al Trice**, the same duo who piloted the sub when it was new, almost 15 years ago.

Submarine begins tests next year

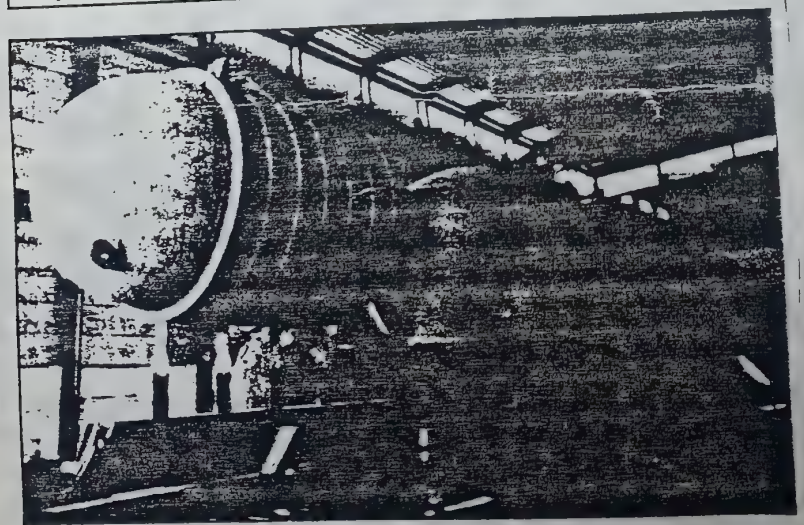
DUST AND SHROUDS covered the partially constructed French submarine Saga (Argyronete) for a period of 10 years while time and technology caught up with it. The submarine, begun as an oceanographic vessel in 1971 by Jacques Cousteau, will finally be completed as a long-range diving support vehicle in 1985.

A joint venture of Comex and the French national oceanographic agency, CNEXO, will conduct tests aboard the submersible after completion next year. Comex and CNEXO took over completion of the vessel in 1982. The submarine, renamed Saga, rests in a port hangar near Marseille.

Comex intends to use the vessel for long-range seabed diver support, to gain immunity from surface weather conditions that plague even the new heavy-weather surface diving support vessels. The technological difficulties that resulted in the stoppage of construction on the submarine have largely been resolved with the substitution of a new power source. Other alterations have been made to the vessel by the Comex/CNEXO team to prepare it for commercial use.

Equipment, design changes for Saga

Original	Change	REASON
Diesel-electric motors	Stirling-hydraulic motors	Increased range, submersion
Steel O_2 bottles, fairing, tanks	Composite materials	Reduce weight, store more fuel
Large number of batteries	Few batteries	Stirling engine power, heat source
Small viewports	Large viewports	Control station for work support
Ambient gas temperatures	Cold storage of gases	Greater storage capability
O_2 for divers only	O_2 for divers or Stirling engine	Greater flexibility for support operations



Comex and CNEXO are completing the long-term seabed support submarine, Saga, in Marseille. The pressure containers, above, will be fitted with a fairing, conning tower, and propulsion unit.

Autonomous mini sub

A contract for an air-independent power system for the Comex Argyronette mini offshore support submarine has been signed by Comex of Marseille and Sub Power AB, Malmo, Sweden, subsidiary company of Kockums and United Stirling.

The Argyronette will be the first support vessel to have this kind of power unit, a new design of long endurance high energy Stirling engine. Based on external combustion it is fuelled by diesel oil and liquid oxygen.

Pressure in the combustion chamber is high, permitting the exhaust gas, chiefly CO_2, to be discharged into the sea at considerable depths with no problems.

The Stirling engine converts the generated heat into mechanical power which is in turn converted to DC electrical energy for the submarine's main grid. This is connected in parallel with the batteries which are kept 'on float' and only engaged as a power source when the Stirling engine power needs a boost.

The contract involves a system for delivery by November 1985, comprising two Type 4-275 engines and a LOX unit, together with integration, testing and installation. The Argyronette trials are planned for 1986.

Submarines of this kind are suited to deep water intervention for a variety of repair or maintenance tasks, also for exploration under difficult conditions, for example icy regions of the far north.

SEA SHUTTLE — SAGA N

Announced about the time of ROV '84 was the formation of International Submarine Transportation Systems, Inc. (ISTS). It is a joint venture among International Submarine Engineering Ltd. (ISE), Energy Conversion Systems, Inc. (ECS) (both are Canadian companies) and COME SA of France. The primary purpose of the jv is the development of a prototype submarine work system with a high endurance power source to work initially in waters which are intermittently or fully ice-covered. While the first power source is likely to a closed-cycle Stirling, the eventual aim is to power the sub with a small nuclear reactor.

This ambitious project is named "Sea Shuttle -- Saga N." As pictured in the artist's concept drawing, the submarine will have the ability to deploy a wide-range of manned minisubs or ROVs (probably 2 at a time) depending on mission. With a crew of 6 and a capacity for 7 other people, including lock-out divers, the Saga N will have the ability to remain submerged for periods up to 30 days (submerged endurance is limited only by on-board stores). Saga N will also have a considerable payload capability for carrying replacement parts and a wide range of tools.

Most submarine specialists will agree that the key to realizing such an under-ice subsea work capability is the practical demonstration of a nuclear power source which is safe, small, lightweight, simple to operate and maintain and costing relatively little to purchase and operate. ECS has designed such a reactor for submarine use.

It is a new class of light water moderated reactor that uses the absolute minimum amount of fissionable material that can sustain a chain reaction under optimum conditions, such that any unprogrammed change in temperature, geometry or materials automatically results in a less reactive condition. If the change is sufficiently large, a shut-down of the reactor will occur.

While the ECS reactor for submarine power has yet to be completed, ECS has built neutron source reactors, 6 of which are currently in use by universities. These, according to ECS, prove the concept and have verified the safety characteristics. These reactors have provided over 40 years of trouble-free operation and are licensed in Canada for unattended operation (the only reactor in the world so licensed, so claims ISTS).

The new reactor will produce approximately 750 kilowatts thermal to yield 70 kilowatts electric continuous, which in terms of small displacement submarines, represents a relative abundance of power. It is estimated that the reactor will power Saga N for 7-10 years before refueling is required.

Such a submarine platform would eliminate the need for a surface support ship, especially in ice-strewn or covered seas, as well as in seas generally hampered by severe weather. Its ability to transport and deploy divers, minisubs and ROVs to work sites makes Saga N an extremely attractive platform for subsea intervention. This $75 million (Canadian) venture has a goal to have Saga N operational as a nuclear-powered vessel by 1989-90.

Sea Shuttle—Saga N Preliminary Characteristics

Length	135 ft.
Beam	18 ft.
Displacement	650 tons
Operating Depth	2000 ft.
Total Power	2.26 x 10 kwhrs^6
Speed (max)	6.0 knots
Payload	8 tons
External Payload Volume	16 m^3
Submerged Endurance Life Support	30 days (+)
Crew	6
Passengers	7
Thrusters:	
Fore-Aft	2
Lateral	2
Vertical	1
Manipulators (Functions)	2 (7)
Coring (length)	10 m+
Sample Collection & Storage	Large
Equip. Deployment & Retrieval	Large
ROV Deployment	2
Atmospheric Diving System	Yes (Optional)
Saturation Divers	Yes (6)
Auto Control	Yes
Onboard Data Processing	Yes

Rechnitzer Leaves Oceanographer's Staff

Dr. Andreas B. Rechnitzer, special assistant to the Oceanographer of the Navy, resigned his post March 1.

Rechnitzer came to Washington in 1970, eventually becoming Assistant Oceanographer of the Navy for Interagency and International Affairs. Here are some of the highlights of his professional life and education:

- A native of the San Diego, California, area, he took his graduate work at the Scripps Institution of Oceanography, earning his doctorate in oceanography in 1956.
- He was involved in the development of a rigid-rotor helicopter.
- At the Ocean Systems Division of North American Aviation Company, he worked on the *Beaver MK IV* submersible and piloted it.
- As scientist for Project Nekton, which operated the bathyscaph *Trieste*, he set a world's depth record which was subsequently broken twice, the final time being the dive that established the permanent record which can never be broken, only tied, of 35,800 feet (10,912 meters)
- He participated in many archeological dives in the West Indies, Caribbean and Mexico. He was president of the archeological diving organization, CEDAM International, for nine years.

Rechnitzer, 60, is an associate of Marine Development Associates, Saratoga, California, established by James G. Wenzel, who formerly headed development of the *Deep Quest* submersible and the Deep Submergence Rescue Vehicles of the U.S. Navy at Lockheed Missile and Space Company; an official of International Maritime Inc., established by Dr. Don Walsh, co-holder of the world's depth record; and has established his own proprietary company.

SUBNOTES VISITS ... CAN-DIVE

CAN-DIVE

Recently, *SubNotes* had the opportunity to visit Can-Dive Services Ltd. at their head office in North Vancouver, B.C. As we reported in the October issue, **Phil Nuytten**, founder of Can-Dive, had just purchased 100% of the voting stock from Oceaneering. Now with geographic constraints lifted, Can-Dive doesn't have to restrict its business efforts solely to Canada, though, to be sure, the Canadian market will be the lion's share of Can-Dive's business in the foreseeable future.

Can-Dive head office in Vancouver, B.C.

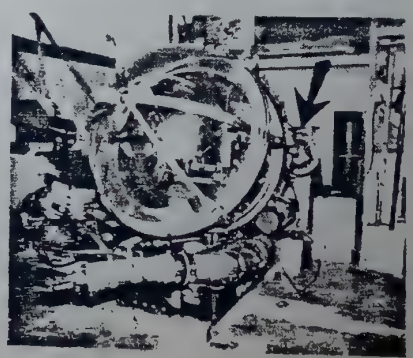
While most of Can-Dive's people and equipment were out on jobs, we did have the chance to tour their spacious facility and to see some interesting equipment. Deep Rover, their pride and joy, was supposed to be on job offshore eastern Canada. But instead, it was in the shop for a little repair job because it was banged up while demobing in Hawaii. There it did some work for the Hawaii Underwater Research Laboratory (HURL) including some dives to 1,600 ft. in beautifully clear water off of Oahu. We got to see some excellent color video of those operations. The footage will be used for sales and training tapes. Back on shore, though, Deep Rover had an accident with a fork-lift and got its port thruster damaged. If you look closely at the photo, you can see the bent Innerspace thruster. But the good news is there's no structural damage.

Your *SubNotes* editor had the chance to sit in the pilot's seat and play submersible driver for a few minutes. The all-round view it provides must be smashing when submerged. The pilot tends to get very hot while on the surface (105 in the sphere) but cools off rapidly subsea. The controls and displays are well placed and one had the feeling of being in complete command. Operators say that it is compared to a helicopter regarding operation and maneuverability.

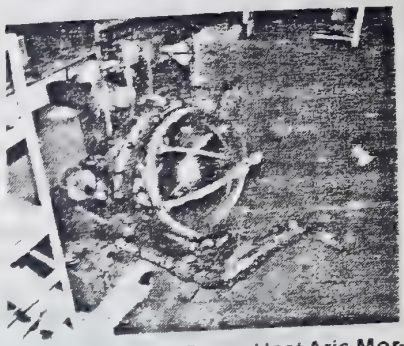
Deep Rover measures 8.2 ft. long x 6.3 ft. in beam x 7.8 ft. high. It weighs 6,800 lbs. in air and cruises at 2 knots submerged (3.2 knots is listed as max speed). It's rated for 3,000 ft. (12,000 ft. is the collapse depth), carries just one person but gives him 150 hours of life support. Deep Rover is designed to operate in an untethered mode for survey and scientific support. For drilling support it is operated in a tethered mode for real time TV and data transmission to the surface.

The sub is equipped with two sensory feedback manipulators, a color sonar and the usual sensors and locating beacons/strobes. It was built by Deep Ocean Engineering in conjunction with Can-Dive Services.

Next to see was the NEWT SUIT, a JIM-like atmospheric diving suit developed by Phil Nuytten. This patented design is scheduled for formal "unveiling" in the spring. The joint design is unique and allows a diver to have about 80% of human movement underwater, whereas a JIM suit allows only 20% mobility. This is done through a series of low-friction joints that maintain internal pressure at one atmosphere and still allow near-effortless movement by the diver. **Aris Morfopoulos**, our guide at Can-Dive, said the NEWT SUIT will "revolutionize" the diving industry and that it will be significantly cheaper than a JIM suit. We were able to try the arm demo model and found we could reach around and scratch the backs of our heads with the hand-operated manipulator. Initially the NEWT SUIT will be rated for 750 ft. as it is designed for



Deep Rover sub in Can-Dive shop. Arrow points to damaged thruster.



Top view of Deep Rover. Host **Aris Morfopoulos** stands in front.

midwater intervention. We will run photos of the new NEWT SUIT in a coming issue.

Other Can-Dive news is that they've just tested an underwater closed-cycle engine which can serve as an underwater generator for the Deep Rover or untethered vehicles of the future. They've also modified in-house one of their two HYSUB-20 ROVs for operations to 5,000 ft. That's on a drilling support job for PetroCanada in water depths up to 4,500 ft. They also have a Mini-Rover and another on order.

This busy company has 125 employees and operates five offices from the Vancouver head office to one in St. John's, Newfoundland. Can-Dive was formed in 1966 and was one of the founding companies of Oceaneering International.

Can-Dive Services Ltd., 1367 Crown St., North Vancouver, B.C. V7J 1G4. Tel: (604) 984-9131, 987-4913; tlx: 04-352566.

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SUBNOTES plus

SEAHORSE II

Long range inspection, survey and patrolling in shallow to medium deep waters (continental shelf) is the main objective for the Bruker SEAHORSE II submarine. Applications for this sub range from scientific research, exploration of subsea resources, pipeline surveys to subsea patrols and security duties.

Compactness combined with relatively high speed (7 knots surfaced or submerged) and endurance (300 nm surface range; 20-30 nm submerged range) are the significant features of this 4-man sub which can operate independently from surface support vessels. On the surface, the pilot can steer the sub from a stand in the conning tower. A TV camera system serves for observation of the surface instead of a periscope when using the snorkel.

Design features include a cylindrical pressure hull with internal T-shaped stiffeners, hemispherical bow section and conical stern. There's an unbolted stern section/engine compartment for easier accessibility during assembly and general refits. It has a large spherical bow viewport for a panorama view of the seabed. The command and instrumentation area are within the forward section. There are 4 comfortable sleeping seats for the crew and the engine compartment is not permanently manned.

SEAHORSE II employs diesel-hydraulic propulsion on the surface and when semi-submerged. Propulsion is electro-hydraulic when fully submerged. Lead acid batteries can be charged while the sub is on the surface.

She comes equipped with an underwater telephone, surface radio, flashlight, radar reflector, surface buoy and underwater TV and photo cameras. She can be fitted with a hydraulic manipulator, extendable legs, lift bags, chain cutters, special tools and so forth. Other special instrumentation and devices can be added according to customer demand. The first SEAHORSE II was launched in August 1983. If necessary, it can accommodate 6 persons.

SEAHORSE II Specifications

Length overall	13 m (43 ft.) (approx.)
Width overall	2.2 m (7 ft.)
Diameter of bow viewport	1.1 m (3½ ft.)
Operational diving depth	300 m (985 ft.)
Surface speed	7 kt. (approx.)
Diesel engine power	180 KW (approx.)
Range surface	300 nm (approx.)
Hydraulic power available	100 KW (approx.)
Speed submerged maximum	7 kts. (approx.)
Range submerged, maximum speed	20 hrs. (approx.)
Endurance, submrgd. cruise speed	20 hours (approx.)
Energy capacity	400 KWh
Life support (oxygen)	900 man hours

AUTONOMOUS MANNED SUBMERSIBLES FOR SCIENTIFIC RESEARCH

by **M. Kaspar** and **C. Anklin**
MARKASUB,
4011 Basel, Switzerland

(Ed. note: This article is a condensed version of the Kaspar & Anklin paper submitted to SubNotes. *Every effort has been made to preserve its technical accuracy.)*

Most of the manned submersibles used for scientific research today are bulky and heavy. The operation of these vehicles is expensive and transport to work sites is laborious and costs valuable time. Therefore, only a limited number of scientists are able to profit from the advantages of a manned submersible.

This article shows that the 2-man sub "E-3" called GEO can perform many scientific tasks efficiently. It also describes the improvements that have been made on the sub to make it a reliable instrument for scientific research.

The development of today's free-swimming submersibles for commercial and scientific applications goes back to the late fifties and early sixties when many subs were built. Two major classes dominated the design at the beginning: shallow water subs for leisure diving and the deeper diving subs for scientific research. Then in the late sixties and early seventies when oil exploration moved offshore, manned submersibles became a basic tool for commercial operations. Perry, HYCO, Bruker, COMEX and some other companies started to develop subs for this work and they became bigger and heavier. Most required special support vessels with appropriate handling equipment and thus were very expensive and out of reach for scientists.

In the last five or six years, the subsea market has changed considerably. Most of the tasks that were done by manned subs can now be done by more cost-effective ROVs or ADS systems. Although many of the old manned submersibles are now for sale at a reasonable price, their transport and operation costs are still too high for the scientific community and, therefore, only a few scientists are able to perform their research under ideal conditions.

There is no doubt about the need for manned submersibles in the field of underwater research. Every scientist needs to gain a maximum of information to be successful. The closer he/she can approach the work site, the more information can be collected.

(cont'd on page 12)

(cont'd from page 11)

So, for a manned sub to be useful to a scientist it must be (1) compact size, (2) simple design and (3) easy to operate and maintain. Compact size simplifies the transport, storage and operation of the sub. Existing research vessels can be equipped with a suitable crane and can be used as the support ship. The simple and intelligent design saves time and costs during the operational and maintenance training.

"E 3"/GEO

The two-man "E 3"-type submersible called GEO is the first prototype of the "E 3" model. It was built for Prof. **Dr. H.W. Fricke** in 1981. It has a steel pressure hull with a domed acrylic viewport in the bow and a hemispherical acrylic dome on top. The power supply unit is located below the pressure hull. Buoyancy and electric thrusters straddle the hull.

GEO at Red Sea site. Note rail launching technique.

GEO can dive to 200 meters (656 ft.). Life support is designed for two people for 7 days. Weight in air is 2.4 tons and payload, including the crew is 660 lbs. (300 kgs). Depth control is by variable ballast and for steering, there are 2 independent electric motors of 500 W power each, placed laterally, which can be rotated through 360° in the vertical. Two more motors in the stern provide main forward thrust.

For safety, 220 lbs. of ballast can be jettisoned manually as well as automatically (operating on the deadman principle and on exceeding the depth limit). The operator can also release a position indicating buoy permitting rescue.

GEO is equipped with a manipulator for picking up samples and there is a pneumatic hammer for breaking off fossil samples. Video, movies and photos are taken through the viewports.

GEO is normally transported on a trailer towed by a Land-Rover. During operations in the Red Sea, GEO was stored in a shed close to the sea. A railway track was used to launch the sub. It was then towed to the work site by a small fishing boat. Once at the site, the crew climbed in the sub, went through the last checks and began the diving program. Maintenance was carried out by the scientists and their technicians.

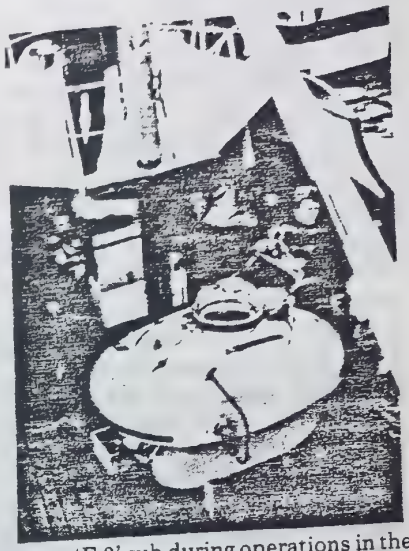
GEO during operations in the Red Sea.

Since the summer of 1981, GEO has carried out more than 400 successful dives in the Red Sea, in various lakes in Austria, Germany and Switzerland and off the Bermudas. During these dives, many scientists, predominantly biologists, geologists and zoologists, carried out their work on site. The sub has been piloted by scientists, technicians and students with no serious incidents.

Based on the experience with GEO and to the specific requirements of a customer who has worked with GEO, the "E 3A" model has been designed. It will dive to 300 meters (985 ft.) and can be transported in the cargo compartment of a jumbo aircraft. There are also small modifications to the basic "E 3" design.

MARKASUB has also designed and built a 1-man "E 2" submersible for operations to 210 meters (690 ft.) and can make an "E 2B" model (1-man) for 320 meters (1,050 ft.) operations.

Collections from surface vessels have supplied the basis for most of man's knowledge about the sea and lakes. However, it is very difficult to interpret the collected samples which give the full information on the quality and quantity of the same itself but only fractional, and sometimes insufficient, information on its



1-man 'E 2' sub during operations in the Mediterranean Sea.

environment. The use of submersibles minimizes the potential risk of misinterpretation of the samples and data which are collected at a particular site and not just somewhere by accident. And submersibles of the "E 3" design will help the scientific community considerably in the quest for knowledge about our watery world.

"CHECK MATE" IS OPERATIONAL

(Condensed from an article by **Claude Olsen**, NUTEC, that appeared in the *Norwegian Underwater Research News*)

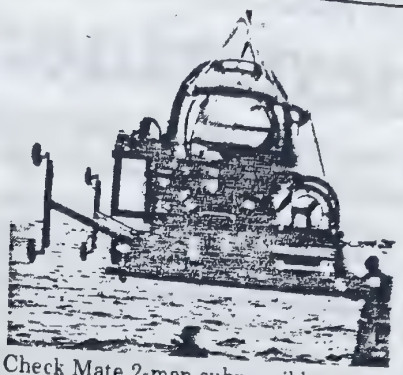
At long last, NUTEC's motorized crystal ball is operational. With seating for two and clear sight in all directions, "Check Mate" is a good way of getting to work on the seabed fast. Furthermore, the sub is now equipped with a manipulator arm developed at NUTEC.

"Check Mate" was completed 4 years ago. But practical problems with both the vessel itself and with the manipulator arms have hindered practical use of the submersible. However, following a comprehensive program of modifications and improvements, the sub was declared operational last year and it was given its first real task in connection with

work for the Skuld project carried out on the seabed outside NUTEC's headquarters in Gravdal.

In April 1984, a 170-ton template for the Skuld project was placed in 20 meters of water in the fjord just outside NUTEC. Two months later, it was moved to a depth of 85 meters (280 ft.) where it will remain for 10 months. A year of intensive testing will simulate 20 years of actual use. The sloping seabed required large quantities of gravel fill to provide an area level to within 30 cm. The site contractor, Lau Eide A/S, engaged "Check Mate" for measurements and inspection of the finished work. This involved as many as 50 dives. Later, the sub was employed to check that the template was properly positioned and to fasten a number of lines. Further tasks will include observing and filming operations on the subsea completion system as it is being tested.

One of the most interesting features of "Check Mate" is that it can carry a passenger who needn't have any particular training in operating submersibles. This allows project leaders and other experts involved in testing and installation of underwater systems to go down and observe their systems in use in a real environment. This will often be more effective than obtaining impressions indirectly via video films and photographs.



Check Mate 2-man submersible.

"Check Mate" will also participate in an NTNF-financed project to develop improved methods for underwater filming and photography. The sub will often be a much less expensive method of making underwater observations than sending down divers. "Check Mate" is rated for operations to 325 meters (1,065 ft.) It was built by Mollerodden A/S.

The new manipulator is hydraulically driven in order to eliminate electrical cables in the arm itself. The arm was constructed from hydraulic cylinders and valves and a self-locking mechanism. These prevent the arm from sagging from a given position. According to NUTEC, this is the 1st underwater manipulator to be built in Norway and is the result of cooperation between NUTEC, Mollerodden A/S in Haugesund and Hydraulikkontroll in Tyristrand. The arm, regarded as a prototype by NUTEC, will be evaluated in a test program. Improved grippers and a number of hydraulically controlled tools are being developed at NUTEC, in addition to a wire cutter and torpedo claw which have already been completed at this Norwegian technology center.

Sophisticated Submersibles

Archimedes, designed in 1960, is still the only vehicle in the world to reach the maximum 11,000-meter ocean depth. *Archimedes'* 200 tons made it too difficult to operate, but the French 9-ton submersible, *Cyana*, designed under the leadership of Cousteau, remains a remarkable device for carrying out scientific observations and underwater operations. Built in 1963 by CEMA, it can explore 20% of the ocean floor. In the past 10 years, *Cyana* and the U.S. *Alvin* explored Atlantic and Pacific mid-ocean ridges as part of the cooperative operation, French-American Mid-Oceanic Underwater Study (FAMOUS). CNEXO plans to put a titanium sphere in *Cyana* to increase its present working depth.

Baptized the *Nautile* in December 1984, a new 18-ton French submersible able to operate over 97% of the ocean floor to depths of 6,000 meters is pioneering new frontiers. Formerly called the *SM97*, *Nautile* benefits from many modern technological advancements: an extremely effective navigation system, a sophisticated data processing and storage system, the use of a titanium pressure sphere, and carbon fiber manipulator arms that are corrosionless and one-half the weight of similar arms made of steel.

Nautile, beginning trial runs this year, will play a large role in the cooperative work to be done by French and Japanese scientists. The effort will study to depths of 5,000 meters the subduction area off the Japan Trench, where the Pacific plate is sinking under Japan at a rate of nine centimeters per year. Recently, a mutual rescue agreement for the *Sea Cliff* and the *Nautile* was signed by the U.S. and France.

Sonat Subsea Services Acquires Santa Fe Underwater Services Division

Sonat Subsea Services Inc. of Houston, Texas announced recently that it has acquired the assets of the Remotely Operated Vehicle (ROV) Division of Santa Fe Underwater Services Inc., a subsidiary of Santa Fe International Corp.

Bruce C. Gilman, president of Sonat Subsea Services, said the purchase of the ongoing ROV business includes contracts and equipment. The acquisition provides Sonat Subsea Services with expanded regional operations in Houma, La., and Aberdeen, Scotland. Santa Fe will retain its existing diving and offshore construction operations.

Sonat Subsea Services Inc., a subsidiary of Sonat Inc., provides high-technology underwater services in support of the offshore energy industry. Sonat Subsea Services has headquarters in Houston, with a regional support base in Singapore. S&H Diving, its Americas-region operating subsidiary, has support bases in Morgan City, La., Galveston and Corpus Christi, Texas.

Deep salvage job for ROV

A recent ROV salvage operation carried out by a Mantis ROV owned and operated by HMB Subwork Ltd, working for British Gas onboard the *High Seas Driller* off West Shetlands, underwent a total continuous dive time of 22 hours in a record 1800ft of water.

A lost anchor and chain was located with the Mantis which was then able to position a transponder enabling the rig to manoeuvre into position over the anchor. A grapple was then lowered to the sea bed and guided into position by the ROV.

The next generation

New ideas for larger manned subs and free-swimming ROVs were put forward at last month's SUT conference on underwater vehicles

The main theme to emerge from last month's SUT conference on the design and operation of underwater vehicles was the continuing development of manned vehicles that show no sign of being replaced by advanced ROVs. The two types will become increasingly complementary, serving different sectors of future markets such as deep water exploration, subsea completions and inspection, repair and maintenance.

These markets will pose new operational problems; for example the next series of fields located north of the North Sea will extend to areas that freeze over during the winter, and the current interest in sea bed mining of minerals such as manganese will demand support services down to 6,000 metres. Umbilical powered and controlled craft may give way to an improved breed of small submarines. Nearer home the revival of activity in one atmosphere subsea completions will call for improved methods of transferring operatives from surface vessels.

Among the latest mini submarines is the Italian Model GMS 16 by SSOS Sub Sea Ocean Services of Milan. With dry displacement 18 tons it is capable of supporting three to four saturation divers. Now under construction it is claimed virtually to double the work capacity of a diving support vessel or semi-submersible. The company plan to follow it with the larger Model GMS 280, having a submerged displacement of 300 tons, cruising speed over 16 knots 650kW/hr of electric power and 25,000 kW/hr of closed circuit diesel power. With no weather limitations the sub can operate all the year round.

The GMS 280 will 'steam' underwater for 750 miles, or alternatively travel 200 miles and stay on the bottom as a support vessel for 14 days, providing 17,000 hp/hours for diving support or other activities before returning to base. It can also be used as a long range survey vessel with a range of 2200 miles at 6.6 knots. In general, applications include: multi-purpose support; maintaining subsea completions; emergency repair on pipelines; atmospheric welding; seabed mining; installing and maintaining deepwater fixed platforms.

The company has also employed its submarine technology to develop an underwater firefighting system, said to overcome problems with conventional firefighting methods such as high topside weight for fixed equipment, long delay in deploying firefighting vessels, ship-to-target distance, poor visibility, and the need for between deck firefighting. The underwater systems typically deliver 4000 tons hour of water at 10 bars from a self contained unit that operates for 14 days before being refuelled underwater. Activation can be automatic, say on pushing the abandon-ship button, or remotely triggered from a support vessel or helicopter.

Also offering mini submarines was Bruker of Karlsruhe West Germany. Their Seahorse 11 was delivered in the summer of 1983 and again requires no support ship, saving operating costs. A 46 ton, 15.5 metre vessel it is suited to depths of 200 metres. Power is presently obtained from a conventional diesel/electric plant but the company plan to announce their own closed circuit diesel, developed together with MAN of West Germany, during 1984.

Highlights of ROV development at the conference included the new concept of U_3 vehicles, an American term standing for untethered, unmanned and underwater. (The conference coined the word Autonomous.)

A free swimming vehicle was described by a team from Heriot Watt University who have designed and tested a system that works. As shown in the figure it is based on an intelligent vehicle that scans, coordinates and acts on the following systems:

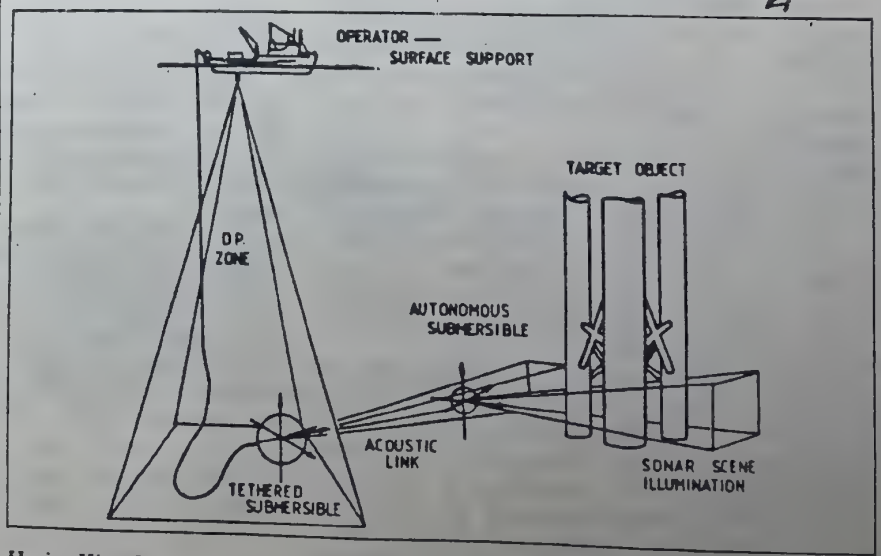
- ☐Energy storage/drag/manoevrability.
- ☐Guidance and control.
- ☐Information and communiction.

The surface support vessel operates a tethered submersible linked acoustically to the U_3 ROV. This free swimming ROV seeks out the target by sonar until within TV range. It then transmits the TV image through the acoustic link to the tethered submersible which feeds the picture through the umbilical to the support vessel.

Other aspects of ROV communication were covered by several papers including one on underwater holography (3D pictures) by the Robert Gordon Institute of Technology, Aberdeen, also the use of stereo TV by the Swedish National Defense Institute.

However, the ROV may soon be employed for such applications as high pressure water jet cleaning as described by A Crook and I Prior of the British Hydromechanics Research Association who adapted a Slingsby Solo for this purpose, defining the requirements as space, payload, surplus power, manipulator dexterity and ability to hold station using a gyroscopic system linked to thruster controls, but also requiring limpet clamps to hold it in place for the actual water blasting.

While there's nothing new about composite pressure vessels — Kevlar epoxy offers high performance for liquid oxygen storage — external pressure resisting hulls are only recently moving to this type of material. A paper by Dr G Tilly, a consultant to Umel, described carbon fibre based atmospheric diving suits based on the JIM series. A prototype tested in 1982 withstood 1,500ft and its successor is designed for 2,000ft. Unidirectional carbon fibre cloth is laid in layers alternating between 0° and 90° from the normal axis. A special vinyl ester resin is used for this composite which provides virtual freedom from corrosion together with the advantages of low weight, high strength and comparative freedom of design. Several mini sub manufacturers, notably the French, are also evaluating carbon fibre for pressure hulls.



Heriot Watt University system for controlling free swimming ROVs by acoustic link

Tackling the diving mission impossible

CHARISMATIC Henri Delauze takes a devilish delight, as his wont, in saying that Comex, the company he founded in 1962 and has taken to worldwide success, is not a diving company.

'No, we are definitely not a diving company. It is too competitive. We call ourselves a subsea and construction company and as such we want to be part of the deep water show.'

The development of Comex over recent years certainly testifies to its gradual abandonment of survey type diving jobs associated with exploration and a move towards heavy equipment. The future for the company is in a mixture of construction and maintenance work, says Delauze. He sees his rivals as companies like Seaway in Norway and Taylor Wharton Williams rather than the likes of Oceaneering, which ironically he once talked to about a merger. He looks back on that negotiation and others with relief that he didn't lose his independent status. For, Comex is very much the vehicle of Delauze even though nowadays the company is spread around the world.

Delauze recognised that for a company like Comex, almost solely dependent on business from overseas, it was important to be as 'national' as possible. The Aberdeen operation in joint venture with Houlder Offshore has 600-700 Brits and a handful of French personnel and has recently had its status enhanced by becoming the ndt centre for Comex's worldwide operations.

Comex Houlder is the model that Delauze has tried to repeat everywhere with the notable exception of Norway where talks last year with Ugland set back the company's plans to have a Norwegian partner. Not that it has significantly affected business in the North Sea, which is split roughly 50/50 between the UK and Norway. Comex was heavily involved in the Statpipe project and of course was responsible for the trial in a Norwegian fjord to show that hyperbaric welding at the 300m water depths found in the Norwegian trench crossed by the Statpipe line was possible.

The company has gone much deeper in working dives, notably its celebrated recovery of a wellhead in water depths of 326m off Labrador, and this autumn it is to undertake a 383m dive for Petrobras.

Bread and butter for Comex comes from the operation of its fleet of dsvs and msvs and Delauze hints that there may be additions soon to the *Orelia*, *Seabex* 1, et al.

Yet Monsieur Comex himself is still the pioneer, and his ambitions at present are very much focused on projects to take divers to 500m for real work. 'I always say 400m is the aim, but I really mean 500m'.

The goal has been a driving force more or less ever since he got interested in diving while a civil engineer, already an unlikely profession for the son of a fairly humble farm family in the south of France. Sensing the possibilities of diving he spent some time in the early 1950s with the legendary Jacques Cousteau, but after three years grew impatient with the lack of any industrial application for the work which he describes light heartedly as 'for the movies'. The two men apparently fell out in the 1960s when Comex got underway, which Delauze always regards as a shame because he was a Cousteau disciple.

One inheritance from Cousteau has great significance today and that is the Argyronete project, now rechristined Saga, which is destined to be the first ever autonomous offshore submarine with diver lock out. A submarine that can, using the Stirling engine concept (subject of recent agreement with Kockums subsidiary Sub Power), stay underwater for a long time offers important advantages for offshore subsea work.

An obvious application for the Saga could be arctic conditions where the ability to remain under the ice would be invaluable. With an attack on the market

Monsieur Comex: Henri Delauze

later this decade (it is due to enter the water in 19867 Comex has gone into joint venture with two Canadian companies to produce a nuclear powered Saga, as opposed to the Stirling engine powered version. The submarine which uses a mini-style nuclear reactor called Slowpoke, apparently in use at a number of Canadian universities and 12 people could be housed subsea for up to a month. The Canadian plan is to have a sea shuttle to offshore exploration facilities in ice infested areas.

Saga is the kind of project that is close to Delauze's heart, always on the edge of the seemingly impossible. In fact Comex spend a large amount of its budget on research recognising this to be its future and indeed Delauze is well known for his unselfish ploughing back of profits he is entitled to as major shareholder. Deep diving and welding techniques are due this year to take Fr10.3 million, robotics Fr13.6 million and the Saga Fr33.5 million, all out of an expected turnover this year of Fr1.3 billion.

The Welding spread for 3DP hyperbaric welding at 300m project

PHYSIOLOGICAL ASPECTS OF

ONE-MAN SUBMERSIBLE LIFE SUPPORT

Dr. I.M. Light
Robert Gordon's Institute of Technology
Offshore Survival Centre

In the event of a manned submersible becomming trapped, the importance of life support and its bearing on the operator's survival is paramount. It is important to consider the basic principles of survival which should include preparation, protection, location, water, food and rescue. The thermal hazards, unlike those encountered under hyperbaric helix conditions were less serious and provided the operator is kept relatively dry, hypothermia should not be a problem at least during the first 24 hours. An extended survival period would pose other threats to the operator and are perhaps more important. The endurance of the life support system in terms of CO_2 and O_2 must be considered in relation to cold stress and oxygen consumption.

Thus if a trapped vehicle operator has inadequate thermal protection, the commensure rise in O_2 consumption may substantially reduce the endurance of the life support system. Adequate thermal protection can be provided and the performance enhanced by the inclusion of a waterproof and breathable outer garmet or fabric.

The comfort and performance of the operator was improved by the provision of better protection for the hands, feet and head.

During relatively short term survival exercise (maximum 24 hours) the other aspects of survival, i.e. water, food, etc., were not important. If however, a longer survival period in excess of 48-72 hours is envisaged, more attention should be focussed on this area. The psychological aspects of boredom, isolation, claustrophobia and communication were not investigated but must also be considered.

SONARLINK WORKS

A successful field test of the SONARLINK video, voice and data transmission system was conducted recently aboard the U.S. Navy's *Sea Cliff* deep submergence vehicle and Lockheed's DSV *Transquest*. Tests were performed in depths of 1,000 to 5,500 ft. during working dives by *Sea Cliff*.

It was a cooperative demonstration between the Navy's Submarine Development Group One in San Diego and Acoustic Systems, Inc., designer and manufacturer of SONARLINK. Engineering assistance was provided by Sperry Field Engineering Services and the Marine Physical Laboratory.

The SONARLINK system consisted of an audio channel and a digital channel. Voice and slow scan video were transmitted on the audio; keyboard data and onboard sensor data were transmitted on the digital. The voice uplink was described as clear as landline telephone and enabled the pilot to speak in normal tones instead of halting speech that occurs when using standard underwater telephone. Live b&w TV was transmitted topside with good picture quality. Also, a color test pattern was sent acoustically from *Sea Cliff* to *Transquest* with hardly any degradation. Digital data was also transmitted nearly error free. Depth and heading info was sent automatically from *Sea Cliff* once per second.

The *Sea Cliff* people are enthusiastic about the SONARLINK performance. They view it as a "force multiplier," offering a quantum jump in communications with topside controllers. Indeed, *SubNotes* had an opportunity to attend a briefing about these dives with SONARLINK working. Voice quality from *Sea Cliff* 5,000 ft. down was outstanding. TV quality was less than on your home set, but one could clearly make out the subsea scene below.

If you require excellent subsea communications in voice, video and digital information, we recommend you contact **Bud Volberg**, 600 Firestone Road, Goleta, CA 93117. Tel: (805) 964-6250; tlx: 691600.

EXTENDED DURATION DIVES WITH ADS (JIM)

A. Gisborne
Admiralty Marine Technology Establishment

The DoT recommendations for endurance of life support systems for one-man tethered submersibles is now 72 hours. The objective of these trials was to evaluate the CO_2 absorption system and establish the O_2 consumption of ADS operators at various work levels so that the endurance of the life support system could be estimated.

As these trials were carried out in water temperatures between 3 and 18°C with dive durations up to 32 hours, the thermal and nutritional requirements of the operators were also given consideration.

The operators were monitored continuously for heart rate, percentage CO_2 in inspired breath and skin and rectal temperatures. O_2 was measured via a pressure transducer connected to the O_2 high pressure supply. The endurance of the CO_2 absorption system was determined by using a measured amount of active absorbent until a 4% CO_2 level was measured in the operators' inspired gas.

The temperature of the absorbent and the inside surface of the pressure shell were also monitored. Results show that O_2 consumption in the "at rest" situation have varied between .26 and .34 litres/min for the various operators and with this system the CO_2 absorbent provided approximately 50 hours life support when used in the "at rest" situation.

Submarines' survival recommendations were followed for the operators' nutritional requirements; these were that a pint of water and 8ozs of barley sugar would be adequate for the survival period. It was found that the operators' consumption of water was very low (½ pint average) and that analysis of blood and urine samples before and after exposure showed no detectable changed.

New Remote Control Subsea Gyrocompass Introduced By Robertson

Robertson has now extended the applications potential of the Robertson Subsea Gyrocompass (RSG) with the development of a remote control.

The remote control facility incorporates a high degree of microprocessor technology. The most immediate benefit for operators will be the ability to adjust the gryocompass without the need to remove it from its pressure chamber. Thus, the RSG can now more easily be incorporated into the overall electronic system.

The RSG has been installed onboard many underwater vehicles, ranging from ROVs to Sea Bed Crawlers. This solution to the problem of underwater navigation is unique, the RSG's north seeking ability and its total absence of drift being of crucial importance to firms engaged in survey work. Actual operating experience indicates that the accuracy of such operations is greatly increased through the use of the RSG, especially where work is performed close to steel structures.

Navy's Bold Bid in Oceanography

Secretary of the Navy (SecNav) John F. Lehman, Jr., in July made official his approval of an unprecedented plan to implement a broadly based program on oceanography proposed by the Chief of Naval Operations (CNO), Admiral James D. Watkins. Watkins' statement was published in this magazine in the June 1984 issue ("Editor's Corner," page 65). Secretary Lehman was expected, at this writing in August, to enunciate his ideas in an address at Oceans '84 in Washington, September 12.

For the first time in the history of the U.S. government, a powerful agency has put its muscle behind an overall effort to make ocean science and technology co-equal with space and weapons programs. The positive tones of both the original CNO statement and the SecNav memorandum authorize actions that demonstrate complete agreement inside the Navy.

The Navy, long a leader in oceanographic research, has drifted in recent years, stifled in part by the President's Office of Management and Budget (OMB) which disapproved ocean-related budget requests of several government departments and agencies. This was due in part to the lack of coordination leadership by any government agency after the demise of the National Council on Marine Resources and Engineering Development in 1972. That leadership should have been assumed by the National Oceanic and Atmospheric Administration (NOAA), the principal agency in ocean and air programs.

Now the U.S. Navy has taken the steps to assume leadership unequivocally.

SecNav's memorandum states that, effective October 1, the Oceanographer of the Navy will be a permanently designated flag officer to be filled by special duty restricted line officers. The one star flag rank is now commodore. All future Oceanographers must be selected from that restricted line designator—1800—or from four newly established unrestricted categories—xx50.

The Oceanographer's billet has become more powerful in that he will report directly to the CNO. What's more, he will be "double hatted" as the Director of Naval Oceanography under CNO (OP-952) with budget responsibilities similar to the Director of Naval Intelligence. He will receive policy guidance from SecNav and the assistant secretary for research, engineering and systems (ASNRE&S).

The Oceanographer will be the Navy spokesman on all oceanographic matters.

Other actions enunciated in the memorandum include:

- Establish an Institute for Naval Oceanography. It will have a super computer (Class VII) and will be linked to universities and research institutions in the U.S. Priority is given in funding the Institute.
- The Naval Postgraduate School, Monterey, California, will receive $11.3 million for an ocean science building.
- An oceanographic research vessel will be constructed for $35 million, to be operational in 1991. It will be assigned for use by the civilian oceanographic research community. A construction plan for oceanographic research ships will be developed by the Oceanographer.
- The CNO and ASNRE&S will optimize the management and use of Navy deep submergence assets for all forms of oceanographic activities. The adequacy of the Navy's non-combatant undersea vehicles will be reviewed.

Other items: the Navy's programs in ocean science and technology will be strengthened; the NROSS satellite program will be supported; the Office of Naval Research program of chairs in civilian academic institutions will be expanded from three to five; a master of ocean science program will be established in conjunction with the current Massachusetts Institute of Technology/Woods Hole Oceanographic Institution graduate program.

The words add up to an ideal program. Now it remains for the Navy to persuade OMB to fund what needs funding now and for the future. It is hoped that generations of secretaries of the Navy, chiefs of naval operations, directors of naval research and oceanographers will remain dedicated to the program.

Was the Emperor Crazy?

Willard Bascom, the director of the Southern California Coastal Water Research Project, has been an oceanographer/engineer since 1945. A medalist of the Marine Technology Society and the Explorers Club, he is the author of over 100 scientific papers and several books, including Great Sea Poetry *and his most recent work,* Deep Water, Ancient Ships.

Once upon a time a central African nation was ruled by an emperor who was both crazy and crafty. He was rich beyond belief with oil and diamonds. On one occasion he felt slighted by a group of coastal nations and resolved to punish them by "killing" their ocean. "I will manufacture the most toxic chemical known in huge amounts and dump it," he thought. "It will destroy their fish and clams and seaweeds." The great golden palace rang with his shouts of glee.

The emperor's first step was to get advice from some of the world's best chemists, biologists and oceanographers about what chemicals to use. These illustrious scientists, considering this to be an abstract technical problem, were glad to help. They debated the effectiveness of DDTs, PCBs, and petroleum products and concluded that for the worst of these to be toxic to the most delicate animal, a concentration of at least one part per billion would be needed. Since the volume of the ocean is over a billion cubic kilometers, this meant it would be necessary to release one cubic kilometer of the toxicant to have any effect at all.

The biggest-possible plant they conceived could manufacture one cubic meter a second of this worst toxicant. This meant 2 tank cars a minute, or about one dozen large train-loads a day. The scientists calculated that, at that rate, it would take 31.7 years to reach the threshold of toxicity in an evenly mixed ocean. They noted this was less than the amount of arsenic naturally present in the ocean and not far above that of copper or chromium, neither of which seems to have detrimental effects.

They reported this finding to his highness with some trepidation, expecting a furious outburst. Instead, the crafty fellow flashed a fiendish grin, "No, creating pollution would be a mistake, Instead, I shall become an environmentalist and merely claim the ocean is already polluted. Then the coastal countries will destroy themselves by spending their wealth in a futile effort to solve a non-problem."

The emperor's plan seems to be working. In spite of a decade of careful research and numerous reports by distinguished groups of scientists to the contrary, much of the public believes his allegation that the ocean is polluted. As proof, they cite a few shallow harbors and enclosed bays where there may indeed be excessive contamination. Such places do need special consideration, but they should not be confused with the open ocean. However, the capacity of the oceans, including open coastal waters, to utilize or detoxify and eventually bury the minor amounts of contaminants that reach them, will keep them safe from civilization as well as crazy emperors. Even so, some environmentalists are still pursuing their dream of pollution.

Some are still trying to show that drilling for oil at sea causes substantial contamination—even after the huge Ixtoc I spill was shown to have minor effects. Oil spills from wrecked tankers still result in alarming headlines. The concern that would be better directed toward the safety of a tanker's crew or the loss of a valuable ship has been replaced by estimate of how much oil could be spilled. This, in spite of the fact that no serious effects were found from the *Argo Merchant* wreck and the principal *Torrey Canyon* effects came from the oil-dispersants used. The *Amoco Cadiz* spill did severely affect the oyster and tourist industries in Brittany for one season (study costs were a large fraction of the losses) and 3200 birds died—but that was only one-thousandth of the number that died on Christmas Island alone in the natural 1982 El Nino current shifts. The oil spill was, of course, accidental; it affected less than one-millionth of the ocean surface. Most oil problems are caused by its molasses-like effects and few by toxicity. Nature rapidly repairs the problems caused by either natural or human-caused events and the loss in any species is very small.

Congressional committees have heard testimony against putting human wastes in the sea, although these are largely composed of food particles and trace elements that are valuable to sea life. Discharge of ammonia and other nitrogen compounds to open coastal waters has come close to being banned by the Environmental Protection Agency on the grounds that these are plant nutrients. Is it conceivable that there is something wrong with putting food and nutrients in the ocean?

Much is still written about "toxic" metals in the ocean in spite of a substantial body of work that shows it is virtually impossible to have enough of any man-induced metal present as ions to reach the levels found to be toxic in the laboratory. Even zinc and selenium are treated as toxic metals, though both are well known to be anti-carcinogens.

Finally, some synthetic organic chemicals such as DDTs and PCBs do reach the ocean. It would be better if they did not and a good deal of effort goes into preventing further releases. Although low levels of these contaminants are widely dispersed in the ocean, their actual toxic effect is small because natural detoxification mechanisms built into all animals cause these chemicals to be metabolized and the products made unavailable by a sub-protein called glutathione. Thus sea animals and the persons who eat them are both protected.

It is hard to imagine that anyone who has spent much time on the ocean or who has studied natural biochemical defenses would seriously believe that ocean pollution is possible except in very tiny areas for very short times. Still, the shapeless threat of it permits environmental societies to raise money that is used to lobby for stronger and even more nonsensical laws. Thus a great effort is being made to convert non-problems into real ones as the emperor forecast. Maybe he wasn't so crazy.

DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

FEBRUARY, 1986

Vol. XIX, No. 1, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned deep submersible design, operation, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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EDITORIAL NOTES AND COMMENTS

Your Editor is delighted to report his return to the San Diego littoral from exile in Northern California. A Christmas card from the Saners advised us of a pending early return from Aussieland. Confirmation of their arrival here was then received from my wife's hairdresser, and we now have finally established contact with Don.

Will Forman expects to have ballots in the mail shortly for election of a new slate of DSPA officers. The incumbents have served long and faithfully for four years, much longer in the case of Jerry Shiller, and rate commendation and a (short?) rest from their duties. Members are enjoined to mark and return ballots promptly.

Jerry Shiller has 1986 dues statements in the mail and issues his plea for response as soon as possible. Don't delay just because the dues are so low! They remain at $10.00 for U.S. and Canadian addresses and $15.00 overseas.

SEA-LINK 2 is in the news, reported to have photographed and recovered components of CHALLENGER's right (i.e., starboard) booster at 1200 feet off Cape Canaveral. Recovery of the booster is, of course, essential to the failure analysis now in progress.

The OCEANS '85 Film Festival at San Diego, California, 11 Nov. '85 had DSPA plankholder Joe Thompson as Master of Ceremonies. Joe was the original DEEPSTAR pilot. He now heads Seavision Productions. Top honor in the Festival went to DSPA Member LCDR Richard Williams for "On The Frontier Of Inner Space"

The October San Diego DSPA luncheon meeting had a good turnout of regulars, augmented by the return to San Diego of Jane and Mac Mackenzie from an extended working and traveling sojourn in China. The speaker was long-time Member Rich Slater who related his and Doug Privitt's operations with the 1700' test depth, 2-man sub NEKTON DELTA, mapping the nuclear device test craters at Eniwetok in the summers of '84 and '85. 144 dives were made in 29 days in '84 and 50 more in '85. The notable success of the operation was in marked contrast to an unproductive series by MAKALII in '80. Noteworthy is the fact that no radiation problems were encountered. Incidentally, Rich passed his 800-th dive during this series.

The November meeting was delayed until 3 December in order that we might hear Sylvia Earle's presentation on the development and design of DEEP ROVER and her 3,000' dives off San Diego in November.

The 16 January '86 meeting was held to discuss elections for a new slate of DSPA officers. President Will Forman appointed a committee to nominate candidates.

On 5/16/85, your Editor had the opportunity and visited the Hawaii Undersea Research Laboratory at Makapuu Point on Oahu and discussed operations of MAKALI'I with Chief Pilot Bohdan Bartko and pilots Dave Foster and Terry Kerby. Transitting DSPA Members should pay them a visit. You will find it a small but interesting operation.

NEWS FROM MEMBERS

(Ed. Note: Sorry about the age of most of the following; but, for the most part, communications between San Diego-by-the-sea and Vacaville were non-existent during my exile.)

Alan Whitfield, Research Submersibles Limited (12/18/84)
"As you may have heard, I have recently joined RSL at their base in Grand Cayman, certainly a pleasant change from the cold of the North Sea. My reason for writing is to discuss the subject of submersible safety in USA and Caribbean waters. Perhaps this can best be achieved by my putting forward two questions: (1) What joint submersible rescue schemes with USCG/USN operating forces are at present in force? What are the details? (2) The USCG has informed me that they have contingency plans to rescu civilian submersibles; have you any knowkedge if this? Perhaps you would be kind enough to discuss the subject at the next DSPA luncheon and forward any information obtained. Should no suitable plan be in action, I would like to consider the idea of organising a "Manned Submersible Assistance Scheme" among submersible operators in the USA and Caribbean. At present RSL has three submersible operations: PC-8 Jamaica, PC-1802 Turks and Caicos, PC-1205 Grand Cayman. All are involved with educational/ scientific programmes. For your information, I am still producing the IUPA

NEWSLETTER. A new one will be out in January."

Larry Megow, Hahn & Clay Heavy Industries (5/13/85)
"On 5/17/85, I made a 530' dive in a Perry submersible off the coast of Provo Island, a part of the Turks-Caicos Islands, British West Indies. Attached is an account of that dive that might be of interest to readers of the DSPA Newsletter.

BEYOND AND BELOW THE REEF

by

Larry Megow

In 1969 I was privileged to make a 3,010' dive in the Pacific Ocean but it was not until May 7, 1985, sixteen years later, that I got to make another sub dive.

The reason I was unable to make other dives is that deep diving submersibles are usually designed for use as work boats to service drilling rigs, inspecting pipelines, for salvage work and, like the Alvin submersible, for scientific research. Normally the cost of operating a deep submersible is very expensive because the sub requires not only an experienced pilot and co-pilot, but has to have a support ship - support surface boats with full crews.

Recently I found out about the possibility of making a 1,000' dive off the coast of Providenciales Island, part of the Turks and Caicos group - British West Indies - with Research Sybmersibles Limited. RSL operates a 4-passenger, 12 ton Perry PC-1802 submersible on Provo Island for pleasure diving.

On 5/7/85 I spent most of the day with the RC-1802 Perry submersible crew, getting the boat ready to dive about two miles offshore between Leeward and Sellers Cut, and then I made a 530' dive with John Jury as the pilot and with two other passengers - Robin and Henry Kessler from Dallas, Texas.

The entire dive was in a veritable fairyland of brilliantly colored sponges, sea weed, coral and fish.

Every one of the 530' down the sharp wall of that reef opened up new and different panoramas - see attached dive profile.

The dive was indeed exciting, educational, fantastic, interesting, different and, most of all, beautiful.

By all means, any of you non-diving people, plan your vacation so that you too can avail yourselves of this once-in-a-lifetime opportunity to make a dive beyond and below the reef.

PROFILE OF CORAL REEF BETWEEN LEWARD AND SELLERS CUT OF PROVO

TURKS & CAICOS ISLANDS
BRITISH WEST INDIES

10 A.M. 11:25 A.M.

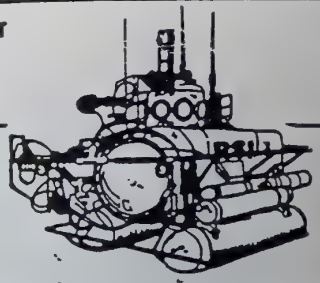
FORE REEF TERRACE

MINI WALL 40 TO 120'

100' 10:18 AM 11:17

FORE REEF ESCARPMENT INFILLED WITH SEDIMENTS

200' 10:20 10:57



DIVER LOCK-OUT SUBMERSIBLE

PC 1802

300' 10:25 10:53

SCLEROSPONGE FRAME WORK

DEEP FORE REEF 200 TO 700'

400' 10:30 10:48

500' 10:40 10:46

10:45

530' DIVE DEPTH PC1802 5/7/85

600'

700'

LITHFIELD FRAMEWORK

ATLANTIC OCEAN

ISLAND SLOPE 700 TO 7,000'

800'

UNCONSOLIDATED SEDIMENTS

INFO BY JOHN JURY—PILOT
LARRY MEGOW—COPILOT

Research Submersibles Limited
P.O. Box 1014, George Town
Grand Cayman, British West Indies
Tel: 809 949 3870 Telex: CP 4210

Larry Megow, Hahn & Clay (7/1/85)
"Attached is a news release from Kawasaki on Japan's first DSRV.

Japan's first Deep Submergence Rescue Vehicle (DSRV) was delivered to Japan Defense Agency at KHI's Kobe Works on March 28.

DSRV will be accommodated on the "Chiyoda," a submarine rescue tender (AS) which belongs to Submarine Flotilla II of Maritime Self-Defense Force.

The keel of DSRV was laid on December 15, 1982 and launching took place on October 15, 1984.

DSRV was developed for the purpose to rescue crews from distressed submarines. Once an accident happens, it is brought to a disaster point by AS. After leaving the ship, DSRV will approach to the distressed submarine following the instructions from AS and by its own sonar system.

Principal particulars of the DSRV:

Length o.a.	: 12.4 m
Breadth	: 3.2 m
Depth	: 4.3 m
Displacement	: 40 t
Cruising speed max.	: 4 knots
Pilot	: 2 men
Propulsion system	:

Main forward propulsion is provided by a stern-mounted reversible propeller, with in AC motor, oil-filled and pressure compensated. A shroud ring around the propeller can be tilted to provide pitch and yaw motion. 4 ducted thrusters, 2 vertical and 2 horizontal, each is driven by an AC motor, oil-filled and pressure compensated.

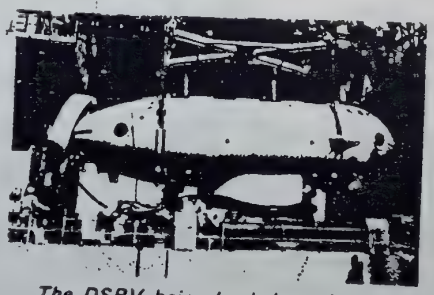
Pressure hull :
Three spheres composed of ultra high-tensile strength steel

Outer hull :
Framework titanium alloy and pure titanium outer skin — FRP

Viewing port :
3 ports made of methacrylic resin

TV camera : 5 sets

Manipulator :
One, hydraulically-powered, 7 degrees-of-freedom ●



The DSRV being loaded on the rescure tender "Chiyoda."

Larry Megow, Hahn & Clay(8/1/85)
"Your readers might find interesting the attached article on salvaging the"invincible" battlefish YAMATO, sunk in 1945.

Not only is the YAMATO the largest battleship ever built (863' long - 72,800 tons, with 16 1/2" thick armor plate), but it will now be undoubtedly the largest ever salvage job.

Too bad some of our subs can't be part of the salvageproject."

The Denver Post/Sunday, June 30, 1985

Japanese plan to start salvaging 'invincible' battleship sunk in '45

The Yamato was and still is the biggest battleship ever built by anybody. It measured 863 feet — fully 180 feet longer than the Missouri, Iowa and Wisconsin, the biggest battleships ever built by the United States.

Its weight — 72,800 tons — dwarfed the 55,710 tons of the "Mighty Mo," the Iowa and the Wisconsin. Its 16½-inch thick armor-plated hull was 4 inches thicker than those of its American counterparts and seemed capable of repelling anything.

It was, much of the world believed, impregnable and unsinkable.

Then on April 7, 1945, in one furious battle 125 miles off the coast of Japan's southernmost island of Kyushu, the myth of the Yamato's invincibility dissipated in a towering pillar of smoke as more than 300 American warplanes attacked and sank it.

In the process, the Yamato and the 2,740 men who sank to the bottom of the sea with it, were largely forgotten by a nation intent on putting its militarist past behind it. Until now.

Yamato, currently resting in two broken and twisted pieces in inky water 1,200 feet below the azure waves of the East China Sea.

But if an ambitious group of Japanese businessmen, journalists and Yamato survivors (there were 276) has anything to say about it, this relic of Imperial Japan's abortive attempt to rule all of Asia, will cease to be a ghost and become a tangible link to the past.

The world's biggest battleship is about to be salvaged.

But unlike the men who dream of raising the Titanic, which sank in 1912 after striking an iceberg in the north Atlantic, the motivation of Japan's Tombstone of the Sea Committee is not gold and jewelry or any other kind of deep-sea treasure.

The motivation to raise the Yamato is to retrieve the bones of the crew members "so their souls can finally rest in peace," said committee spokesperson Jun Henmi, author of the prize-winning bock, "Yamato and Her Crew."

Salavage operations, which will use a compact three-man, French-made submersible vehicle called the Moana III, will begin on Aug.

Kevin Parker, SUBSEA, Ltd. ((9/1/85)

"It is some time since I heard from the DSPA. I realize that my dues for 1985 are due, but I intend to send a cheque to cover some other items also. I have written in the past and requested another pricelist for DSPA stickers an T-shirts. Could please send me a list and the subscription requirements and I will send you some money by return post. I am still working with PIONEER 3. She has had a very busy year. First of all with Elf Aquitaine in the Norwegian sector doing structure cleaning and inspection, then to the Ninian Field in the British Sector doing the same tasks, and now she is in the Gulf of Mexico onboard the OCEAN PROSPECTOR doing drill support. PIONEER 3 has carried out 280 dives and clocked up just over 1000 hours, and she is only ten months old. The vehicle has proved to be a very reliable and powerful vehicle. In order to

offset the weight of extra equipment carried, at one stage last year, she was fitted with 1264 lb of added buoyancy, and performance did not seem to be affected. She has carried two manipulators, a Kraft position feedback, a Merpro manipulator, a large variable geometry stand-off frame, a stereo camera (stills), a T.V.P. camera (color slides and B.W. camera integrated), a color camera, andtwo S.I.T. cameras, oh, and a wide angle B & W camera, a wire brush, and two switchable C.P. probes on the same dive (also a low pressure jetting pump, but it was n't used). Just now, SUBSEA has 49 vehicles on tje field;and PIONEER 10, to make it a round 50, is due in New Orleans this month. PIONEER 11 and 12 are being built. Reference my previous mention of PIONEER, it has proved to be an operator's dream. I'm not sure just how long I will be in the States. Please pass along my regards to the committee the next time you all meet. If I get the chance I am going to get in touch with Harold Criger in Houma, LA , while I am down here."

Larry Megow, Hahn & Clay (10/14/85)
"On October 4, 1985, I was one of the approximately 200 dignitaries invited to attend the impressive ceremony for the Change of Command of the 20,000' submersible SEA CLIFF. I asked Lieut. Bruce Bosshard, the new skipper,to put me on the list for making a 20,000' dive, but he said they had so many important dives scheduled that it would be a long, long time before they would consider a civilian on board."

SEA CLIFF REBORN by Larry Megow

In 1963 and 1964 the 84" precision machined-in-and-outside HY-100 hulls for the deep diving submersible Sea Cliff, along with sister boats Alvin and Turtle, were manufactured by Hahn & Clay in Houston, Texas. All three boats were originally designed for diving 6,000'. Alvin was christened in 1964, but Turtle and Sea Cliff were not launched until 1968.

In early 1984, after 1502 successful dives, Alvin's HY-100 hull was changed out for a titanium hull capable of diving to 13,500'.

Turtle and Sea Cliff were later upgraded from 6,000' to 6,500'. Turtle is still diving for the Navy to 6,500', but after extensive conversion at Mare Island in 1983 (preceded by several years of detail design and qualification tests), Sea Cliff emerged as the world's first deep diving submersible capable of diving to 20,000' - almost four miles.

From 1968 through 1984, Sea Cliff made almost 600 successful dives with her original HY-100 hull.

On March 10, 1985 Sea Cliff made her maiden dive to 20,000' in the Middle America Trench off the coast of Acapulco, Mexico.

On October 4, 1985, at the North Island Naval Air Station

(Coronado), San Diego, after 120 working dives (some down to 18,000') the Navy, in a simple and reserved but impressive ceremony, celebrated the Change in Command at which LCDR Richard B. Williams was relieved by LT. Bruce H. Bosshard. LT. Bosshard is now Sea Cliff's new chief pilot.

Approximately 200 invited guests attended the sixty minute ceremony and were entertained by the 25 person Base band with stirring marching band music.

The setting was beautiful. The makeshift 234 chair theater was ringed with 91 colorful flags - one from each of the fifty states and the rest were signal flags.

Standing majestic and proud across the front of the theater was the gleaming white 31.5' long, 58,000 pound, three man Sea Cliff, with a bright red conning tower and topped by a big American flag - it was awe inspiring.

Sea Cliff is classified as a "manned, non-combatant, untethered submersible. To be used primarily for deep ocean recovery, search and scientific research".

Sea Cliff is powered with silver-zinc batteries that energize her electrical systems, two side pods maneuverable to 360°, as well as powering the main stern propulsion propeller.

Sea Cliff, fully equipped with all the necessary diving equipment including a 35mm still camera, a TV camera and two electro-hydraulic manipulators, has a life support endurance which far exceeds her normal 16 hour mission profile.

In the event that Sea Cliff should become trapped or damaged while submerged, she is equipped with several jettisoning features which would enable her to bring the crew safely to the surface.

Sea Cliff's remarkable 20,000' capability now allows the U.S. access to over 98% of the world's ocean floor. The inner-space ship can explore an area roughly six times the surface of the moon.

Several other members of the Deep Submersible Pilots Association, including Will Forman, Andy Rechnitzer and Bob Worthington, attended the impressive ceremony.

It was gratifying for me to be a part of this historical transfer-of-command event and for having had the opportunity to help play an important role in the birth of Sea Cliff - way back in 1964.

Andy Rechnitzer (1/22/86)

DEEP ROVER REACHES 3,000 FOOT DEPTH RATING
Excerpted for DSPA by Dr. A. B. Rechnitzer
from a Report Prepared by Dr. Sylvia Earle

Three times within a week the DEEP ROVER one-person submersible attained its rated depth limit off southern California. Graham Hawkes, designer and builder, was the first to reach 3,000 feet off San Clemente Island. The event was covered by KGO television, San Francisco. Hawkes left the surface at 1615 and returned at 2010, 21 November, 1985. At 2355 Dr. Sylvia Earle began her descent to 3000 in the same location. She returned 4 hours and 28 minutes later, on 22 November. At the 3000 foot contour she carried out observations and photographic documentation of benthic organisms. A special biological collecting device developed by Dr. Michael Jordan, University of North Carolina, was used to capture an assortment of midwater fish and invertebrates. Kim McCoy, Ocean Engineering and Measurement Systems, installed a continuous recording temperature, depth, and salinity instrument. Excellent profiles of these parameters was obtained. At 1138 on 22 November Mr. Phil Nuytten, President of Can Dive and owner of DEEP ROVER took her down to 3000 feet--the third full depth descent within 24 hours. He returned at 1515 and reported extensive "fields" of unspent munitions between 2900 and 3000 feet! None were recovered.

A number of orientation dives were made available. Dr. Kathryn Sullivan, Andy Rechnitzer, Dean Lehr (owner Lehr's Greenhouse restaurant won his dive at a fund raising raffle) were among those who were being prepared for deeper descents into the Scripps Canyon. Unfortunately, weather and sea conditions did not allow the planned schedule to be followed.

This series of dives follows a month long dive series into the Monterey Canyon by Dr. Bruce Robison, University of California, Santa Barbara.

DEEP ROVER has returned to Canada and no specific future operations are known at this time.

(Excerpted by Andy Rechnitzer
from February 86 issue of Underwater USA)

PIERCE WILL ATTEMPT TO REFLOAT BRITISH LUXURY LINER TITANIC

Welshman John Pierce, 44, has a dream--to raise the TITANIC, haul it back to its original British port in Southampton, have it completely restored and then sail it again on the maiden voyage it never completed to New York City.

Despite pleas from several historical societies and pending legislation in the U. S. Congress to leave the ship rest in its watery grave some 540 miles off Newfoundland and 13,000 feet below tyhe surface of the North Atlantic, Pierce is going ahead with his plan to raise the ship.

Cost for thge TITANIC project is estimated in the hundreds of millions of dollars, but Pierce refuses to discuss financial plans.

He will survey the wreck site this summer using unmanned submersibles, the same devices he says he will luse to attch the hydrogen filled bags to the ship.

(Note: Dr. Bob Ballard, Woods Hole Oceanographic Institution, was one of the principals that located the ill-fated ship. He will be working San Diego with Submarine Development Group One and the Marilne Physical Laboratory, University of California, during much of 1986. He will return to the site of the TITANIC summer of 86. In case you missed it Don Walsh and Don Keach were technical advisors for the feature film "To Raise the TITANIC". Texas millionaire Grimm says he didn't find it in several trys, but that doesn't mean he won't try to reach the TITANIC before some of the others.)

Dr. Fred N. Spiess, professor of oceanography at Scripps Institution, has been elected to the National Academy of Engineering. This is the highest professional distinction that can be conferred upon an engineer. Dr. Spiess is known as one of the original designers of the FLIP ship and his present work with the DEEPTOW research vehicle.

A Titanic Coup for Science

"All the News That's Fit to Print."

The New York Times.

THE WEATHER.

TITANIC SINKS FOUR HOURS AFTER HITTING ICEBERG; 866 RESCUED BY CARPATHIA, PROBABLY 1250 PERISH; ISMAY SAFE, MRS. ASTOR MAYBE, NOTED NAMES MISSING

Col. Astor and Bride, Isidor Straus and Wife, and Maj. Butt Aboard.

"RULE OF SEA" FOLLOWED

Women and Children First Put Over in Lifeboats and Are Supposed to Be Safe on Carpathia.

PERISHED AFTER CLOSING

FRANKLIN HOPPER, N.A. DIES

HERO OF THE LINER JOHNSON

Biggest Liner Plunges to the Bottom at 2:20 A. M.

RESCUERS THERE TOO LATE

WOMEN AND CHILDREN FIRST

SEA SEARCH FOR OTHERS

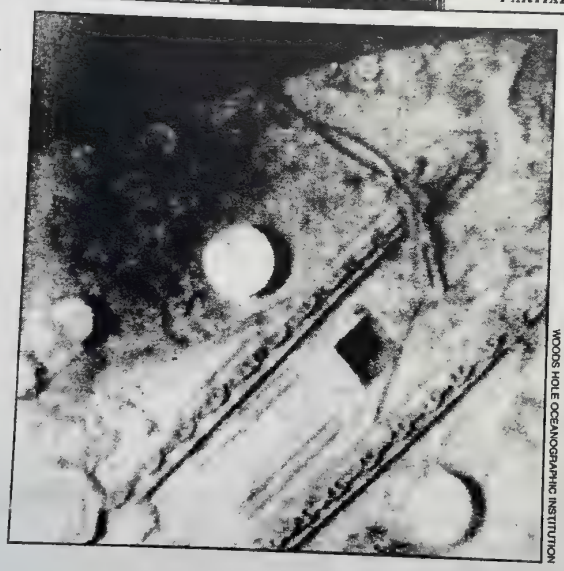
OLYMPIC SENDS THE NEWS

The Lost Titanic Being Towed Out of Belfast Harbor.

PARTIAL LIST OF THE SAVED.

CAPE RACE, N. F., April 15.

CULVER PICTURES



WOODS HOLE OCEANOGRAPHIC INSTITUTION

Seventy-three years after the *Titanic* sank on maiden voyage, the tiny deep-sea probe Argo made photo at left of her deck, viewed from above.

It was a dazzling display of the huge strides being made in deep-sea technology—a stunt that left the world agog. The camera's unblinking eye descended through 2½ miles of murky ocean and 73 years of mystery to find the legendary S.S. *Titanic*.

A robot carrying underwater cameras and strobe lights first picked up the eerie scene on the floor of the North Atlantic in early September, flashing to a ship above images of the famed ocean queen. Though mangled at the stern, she remained 75 percent intact, looking much as she did when she sank on the night of April 14, 1912.

Scientists of a joint U.S.-French expedition on the research vessel *Knorr* were elated—then sobered—by views of luggage, crockery and wine bottles scattered around the wreck in which 1,513 persons perished.

Dubbed "unsinkable" because of her state-of-the-art double hull and sealed compartments, the 900-foot liner plowed into an iceberg on her maiden voyage from Southampton, England, to New York. Only 705—mostly women and children—found places on lifeboats and survived. Until September 1, when the liner was found at about 13,000 feet some 370 miles off Newfoundland, the *Titanic* had lived only in songs, movies, books and memory.

The discovery was made possible by a high-tech marriage of supersensitive sonar and powerful cameras that is revolutionizing ocean science.

A French team in July narrowed the search area with sonar, but it was the *Knorr* team that found the wreckage after three weeks of scanning images transmitted by the Argo, a 12-foot-long robot suspended from the pilot ship by cable. One of the boilers of the *Titanic* suddenly loomed below. "Our initial reaction was excitement, then a coming down off that to realize we had found the ship where 1,500 people had died," said expedition leader Robert Ballard of the Woods Hole Oceanographic Institution in Massachusetts.

What makes the Argo remarkable is its ability to take sharp pictures 100 feet from the ocean floor under the pressures of 2½ vertical miles of water. Combined with graphs made from the probe's sonar, the technology yields a much clearer view of the ocean bottom than ever before.

Treasure hunter Mel Fisher used advanced sonar and computers in July to find a Spanish galleon's treasure off the Florida coast. Another deep-sea robot using the same technology found and retrieved the small "black box" flight-data recorders from the 2-mile-deep wreckage of an airliner that crashed off Ireland on June 23.

Scientists say such finds are only beginning. Already, robots are being used to survey and repair telephone cables—and marine geologist Bill Ryan of Columbia University says they are vital in finding deep-sea minerals and exotic life forms around hot springs at extreme depths. Potential military uses include retrieval of stray warheads and location of potential sites to hide missiles.

Scientists aboard the *Knorr* spotted no human remains among the debris around the *Titanic*. Most doomed passengers are thought to have been swept from the deck as the liner went down.

Viewing the ship as a memorial to those who died, the scientific team said it opposed any attempt at salvage—and would keep her precise location a secret.

Still, speculation about the value of rumored treasures aboard the *Titanic*, as well as the prices collectors would pay for a teacup or a butter knife, immediately brought out the hunters. British salvage expert John Pierce announced that he wants to raise the mammoth liner with inflatable canvas bags. Texas oil millionaire Jack Grimm said that he will continue a years-long quest. And Commercial Union Insurance Company of London, a descendant of insurance firms that insured the ship, said it would consider salvage offers.

One of the few living *Titanic* survivors voiced strong opposition to disturbing the hulk in any way. Said Eva Hart of London, who as a 7-year-old waved goodbye to her father from a lifeboat: "You don't go poking around in someone's grave." □

Flagship designation given SEA CLIFF

SEA CLIFF was chosen to be Flagship of the Year of the Ocean by the Year of the Ocean Foundation and the Marine Technology Society. She was chosen in recognition of her historic dive to 20,000 feet in the Middle America Trench. SEA CLIFF will carry the Year of the Ocean emblem, symbolizing the continuation of the programs that were initiated during the Year of the Ocean.

The Year of the Ocean was proclaimed by President Reagan and Congress to increase public awareness of America's dependence on the world's oceans and of the vast areas of sea floor within the Exclusive Economic Zone. The Foundation was established to assist in fulfilling this mission.

The United States led the world to the ocean's deepest known depth in 1960 when bathyscape TRIESTE made her dive to 35,800 feet in the Marianas Trench.

In 1983, the SEA CLIFF underwent a conversion to increase her capability from 6,500 to 20,000-foot operating depth at Mare Island Naval Shipyard near San Francisco. She was lengthened four feet and fitted with a new Titanium pressure hull, new high capacity silver-zinc batteries, and a sea water variable ballast system. By comparison, the 31-foot, 30-ton SEA CLIFF is roughly one third of TRIESTE's size and can be transported by C-5 aircraft from her San Diego homeport to remote ports anywhere on the globe.

After completing a deep ocean recovery mission, and following months of careful workup, SEA CLIFF made her deep dive off the coast of Guatemala on March 10, 1985. The dive was supported by the 275 men and women who crew TRIESTE II's former support ship, USS POINT LOMA.

Presentation
will be 2 p.m.
Saturday, August 24

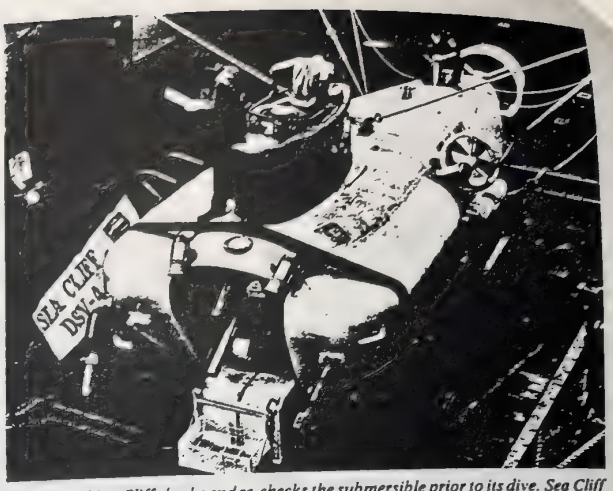
Approximately two weeks after SEA CLIFF's dive to 20,000 feet (6,096 meters), the French submersible NAUTILE followed with a dive to 6,000 meters in the Puerto Rico Trench.

"SEA CLIFF is a national asset whose primary mission is the recovery of small objects from depths to 20,000 feet," said CAPT John Maurer, Jr., Commander of Submarine Development Group 1. "Missions to ensure her readiness also provide excellent opportunities for oceanographic research."

Requests for scientific services of SEA CLIFF, and other Navy deep submersibles, are coordinated through the Office of Naval Research.

The 20,000 foot dive was the final step in an extensive series of tests comparable to the space program. The "20K" dive team was made up of Navy submariners: LCDR Richard Williams of Portland, Oregon; LT Al Mason of Medford, Massachusetts; and ETC Dave Atchison of Scio, Oregon.

"More than 1,000 people across the nation were involved in the conversion and test program," said Williams, SEA CLIFF's Officer in Charge and the Command Pilot. "The teamwork invested by these people — both civilian and military — at sea and ashore — was the hallmark of this venture into the deep ocean. Credit for the success of the mission is shared by all who were involved."



The crew of Sea Cliff checks and re-checks the submersible prior to its dive. Sea Cliff is a unit of Submarine Development Group ONE, based in San Diego, CA.
U.S. Navy photo

Navy's Deep Submergence Vehicle Reaches New Depths

Like many other submersibles, the U.S. Navy's Deep Submergence Vehicle (DSV) *Sea Cliff* has had the equivalent of two lives. The first life after being built, along with the sister sub *Turtle* by the Electric Boat Division of General Dynamics Corporation in 1968, was as a workhorse general utility vehicle capable or diving 3657 meters (12,000 feet).

Then, faced with the fact that the DSV *Trieste II* was nearing the end of its useful life, the Navy decided to give the *Sea Cliff* a complete overhaul, including a new titanium pressure hull capable of operations at 6096 meters (20,000 feet).

When she became operational after the refurbishment, she was taken to increasing depths in a conservative testing program. In March of this year she reached her maximum depth in the Middle America Trench off the coast of Guatemala. Her skipper is LCdr. Richard Williams, a nuclear trained officer.

Sea Cliff is a general purpose vehicle equipped for deep sea research and object recovery

Submarine converted, Navy says

The Associated Press

WASHINGTON — The Navy said yesterday a tiny three-man submarine named the Sea Cliff had successfully completed a conversion for "deep submergence" work by making an ocean dive of 20,000 feet off the coast of Central America.

Although Navy officials would not formally confirm it, the conversion project has apparently turned the Sea Cliff into the Navy's deepest diving submarine.

The service also announced a new ocean surveillance ship, the Persistent, will be launched Saturday by the Tacoma Boatbuilding Co. in Tacoma, Wash.

The Sea Cliff is one of three so-called "Turtle-class" deep-diving submarines constructed in the late 1960s primarily for ocean research work. Both the Sea Cliff and its sister, the Turtle, are assigned to the Navy's Submarine Development Group One in San Diego. The third — the Alvin — is operated for the Navy by the Woods Hole Oceanographic Institution in Massachusetts.

As originally designed, the Sea Cliff and the Turtle had a standard operating depth of 6,500 feet. By comparison, the Navy's most modern ballistic missile and attack submarines can operate only at about 1,000 feet and 1,500 feet, respectively.

The 31-foot Sea Cliff, however, has now been fitted with a special titanium hull and silver-zinc batteries, the Navy said. This it "the only vessel in its class that can now operate independently at 20,000 feet for more than 16 hours," it said.

"Sea Cliff's new operating depth provides access to over 98 percent of the world's ocean floor," the Navy added.

It said the vessel made the 20,000-foot dive on March 10 in the Middle America Trench off the Pacific coast of Central America.

While the Navy routinely refuses to discuss the operating characteristics of its ships, the authoritative Jane's directory says the Navy has two Deep Submergence Rescue Vehicles for use in case a submarine sinks, each of which can dive to a depth of 5,000 feet.

The directory also says the Navy has one "NuclearPowered Ocean Engineering and Research Vehicle," operating depth unknown; and one "Trieste-class" diving vehicle that was designed to operate as deeply as 20,000 feet but normally ventures only about 12,000 feet down.

A Navy source who asked not to be identified said the nuclear-powered research vehicle was not designed to operate as deeply as the Sea Cliff.

Although now retired from service, the first Trieste was a bathyscaph that the Navy used to reach a record depth of 35,800 feet in the Marianas Trench in 1960.

The Navy said the Sea Cliff will be used for inspection, research and "recovery tasks in the deep ocean." The Navy said that latter statement meant the sub could retrieve relatively small objects on the ocean floor.

The Persistent, meantime, is a surface ship designed to "collect, process and transmit acoustic data." After commissioning, it will be assigned to the Military Sealift Command.

Deputy Assistant Navy Secretary Fred Davidson will deliver the principal address at the Persistent's launching Saturday. The vessel is 224 feet long, 43 feet wide and displaces 2,285 tons, the Navy said.

- JAMSTEC says it will order a submersible capable of 6,000 meters to be delivered at the end of this decade. Estimated cost: $45 million (US). Will be built by Mitsubishi or Kawasaki. It will be called the *Shinkai 6000*. Mitsubishi built the *Shinkai 2000* for JAMSTEC.

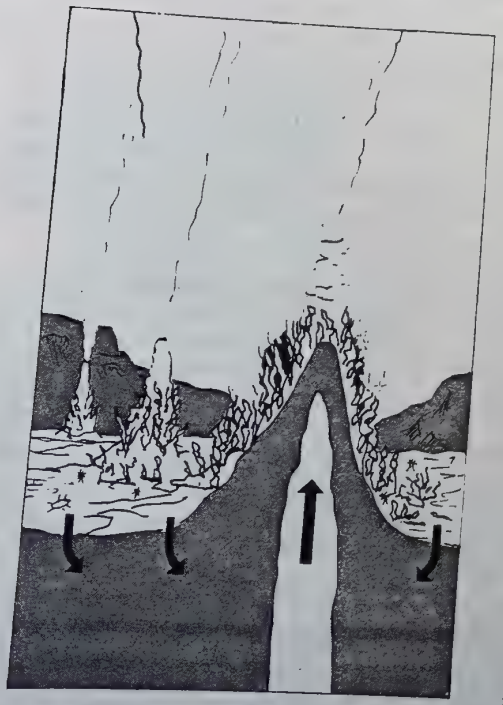
DEEP FLIGHT SUBS

Deep Ocean Engineering has introduced concept designs on a new series of small, autonomous submersibles. They will feature low drag hydrodynamic hull shapes producing longer range and faster speeds than available small subs. "Mission payload pods" will enable a modular approach to be used. For example, during a search mode, the subs can be provided with extra range battery wing pods and releaseable acoustic markers. Once a target is located, the wing and nose pods can be exchanged for bow thrusters and manipulators for mode effective working capability at the defined sites.

In the series, there are FALCON, a one-man sub outfitted for search missions primarily, but does have some manipulative capability. Then there is EAGLE which has advanced manipulative capabilities. Finally, there is BLACKBIRD, basically a larger FALCON with extended midsection for extra range (300 nm vs. 25-30 nm for the others).

An Oceano Instruments underwater positioning system has contributed to an exciting scientific feat. With the help of one of the company's Long-Baseline systems, implemented by Lyman Burk (field operator at the U.S. subsidiary), scientists have verified and explored previously unknown hydrothermal vents in the Atlantic Ocean.

The successful mid-summer research cruise on the United States National Ocean and Atmospheric Administration's vessel "Researcher" took place under the scientific direction of Dr. Peter A. Rona. Scientists from the Atlantic Oceanographic and Meteorological Laboratory, the Florida Institute of Oceanography, and Cambridge University participated with N.O.A.A. in the operation.



Artist's conception

During the voyage the scientific crew repeatedly explored deepsea hydrothermal vents located at the bottom of a volcanic rift valley. The crew was able to locate, photograph, and dredge the vents.

The vents were detected at the beginning of the first towed underwater camera run when scientists noticed an abnormal reading from a thermistor probe. An Oceano Instruments Long-Baseline system was used to navigate and track the subsea camera and dredge used later, at water depths exceeding 3,000 meters.

Burk later explained that the staff was repeatedly able to guide the camera into the vent area following its discovery. "On the last day we were able to put a dredge right over the vent and drop it right on top of it," Burk said.

"Due to the severe topographical nature of the Mid-Atlantic Ridge, the Oceano Recoverable Transponders used were moored 200 meters above the seafloor," Burk explained. "We wanted to insure clear acoustical paths for our navigation and tracking work."

A relay Transponder was mounted on both the camera and dredge to determine real-time subsea positions. The seabed Transponders were moored approximately 5,000 to 6,000 meters apart. Consistent acoustic rangers in excess of 8,500 meters were achieved during the operation.

Undersea Mystery

When Dr. Robert Ballard, a geologist, discovered active hydrothermal vents near the Galapagos Islands in the Pacific Ocean off Ecuador he also uncovered a natural mystery. Colonies of tube worms, clams and other plants and animals lived around the vents in the darkness of the deep ocean.

It didn't take long for marine biologists to examine samples of the sea life that exists by a chemosynthesis food chain based on the minerals dissolved in the warm—and even hot—waters.

Now, after several years, such colonies have been found along deep seafloor spreading areas with their volcanic activity.

The question is, how do these invertebrate families colonize new vents? The vents with their water ranging in from warm to a hot 380° C support bacteria that reduce carbon dioxide to organic carbon and serve as food for a variety of living things.

Since the vents have life spans of a few decades, the mystery is how they move to new vents. One theory is that larvae are produced in great numbers, and being able to survive in 3° C sea water, are spread by ocean currents to new warm spots.

Scientists embark on expedition to study depths of Lake Superior

SAULT STE. MARIE, Mich. (AP) — Mysterious "small white objects," beer cans and remnants of gill-net fishing gear greeted scientists Tuesday as they embarked on an unprecedented submarine expedition to study the depths of Lake Superior.

"I think everything went as we expected," David Long, an associate professor of geochemistry at Michigan State University, said from aboard the research ship RV Seward Johnson. "Things are running pretty smoothly right now. The lake looks beautiful."

Two scientists and two crewmen descended into Whitefish Bay during the morning in the Johnson Sea-Link II, which will be ferried across the world's largest freshwater lake over the next four weeks by the Seward Johnson.

The researchers planned to test equipment, including a clawed, mechanical arm, to be used in obtaining sediment and water samples during the voyage which is to include a dive to 1,333 feet, the deepest point in the Great Lakes.

The $500,000 expedition is sponsored by the National Oceanic and Atmospheric Administration and is the agency's first venture into the Great Lakes, according to William Cooper, a Michigan State zoologist.

The four-man, battery-powered Sea-Link II made its first dive to 55 feet, then on a second dive went all the way to the bottom of the bay, 150 feet deep at that point, he said.

Michigan State zoology professor Paul Groll and Ray Argyle, a U.S. Fish and Wildlife Service researcher, were on Tuesday morning's dives.

Groll told The Associated Press in a radiotelephone interview from the Seward Johnson that he spent nearly three hours searching unsuccessfully for gill nets lost by commercial fishermen. Researchers hope to determine the derelict nets' effect on the fish population.

Long said the researchers did locate broken, 20- to 30-foot-long posts used to hold the nets in place.

In addition, Groll said: "We have pictures of small white objects. We don't know if they're animals or fungus; they may be geologic in origin. We don't know what it is."

Apart from the gill net posts, the only other man-made objects sighted during the morning dives were "lots of bottles and beer cans," Groll said.

The Sea-Link II is equipped with cameras to make videotape recordings of the lake bottom as well as color slides, Long said. Between 700 and 1,400 slides would be made during each dive.

The submarine's batteries allow it to operate for three to four hours, but then require about three hours to recharge, Long said.

Groll said the 22-foot submarine was "pretty comfortable."

The expedition was to remain in Whitefish Bay in extreme southeastern Lake Superior through today, Long said. It will then head northwest and due west for the next phase of the expedition, ending July 31. Two more phases are to begin in August.

Divers have reached the bottom of southern Lake Michigan near Chicago and have found sunken ships in other parts of the lakes, but this expedition is believed to be the most extensive of its kind, Long said.

Scientists comb lowest depths of Lake Superior

MARQUETTE, Mich. (AP) — Scientists searching the lowest depths of Lake Superior have found few life forms 1,300 feet below the surface of the world's largest freshwater lake, researchers said yesterday.

The dive Tuesday by a 22-foot submarine to the bottom of the lake provided more data about life a quarter-mile below the lake's surface than had been discovered in decades of research, expedition coordinator William Cooper said.

The 1,319-foot dive about 40 miles off the shore of Munising on Michigan's Upper Peninsula was the lowest depth reached by humans in the lake and was possibly the lake's deepest point, scientists said.

Three aquatic animals seemed to dominate the environment — burbot, a 2-foot-long fish that digs trenches in which to live; sculpins, a fish about 5 inches long that lives in nests on the lake's bottom; and hydra, a tiny, slender animal related to jellyfish, Long said.

Japan to build deepsea submarine

Japan's Science and Technology Agency has set specifications for a deepsea research and observation submarine called *Shinkai 6000*. The sub's maximum depth will be 21,500 ft, which will allow it access to all portions of Japanese waters of economic or geotectonic interest. The hull of the 30-m-long vessel will be fabricated of titanium alloy to conserve weight. Completion is scheduled for 1989.

Richard Bennett and the 14-foot submarine he hopes will help him find a $300-million treasure

By United Press

Homemade Sub Seeks Riches

Milwaukee

In the twilight hours one recent night, Richard Bennett and two friends quietly launched a homemade submarine.

They were preparing for an assault on a 122-year-old sunken treasure from France worth an estimated $300 million, which is believed to be hidden on the bottom of Lake Michigan off Poverty Island, a tiny speck of land near the coast of Michigan's Upper Peninsula.

Bennett, 47, who began the search 18 years ago, hopes the 14-foot underwater craft he built in his garage will aid in the hunt — a solitary quest until a few weeks ago, when treasure hunter Mel Fisher began bringing up an estimated $400 million in booty from a sunken Spanish galleon off the coast of Florida.

Now, Bennett said, he has been besieged by people wanting to invest money in his venture in hopes of a Fisher-style payoff in which they could receive many times what they invested.

Bennett has been test-diving the submarine in a local quarry and plans to try it in Lake Michigan in September.

"I'm interested in the Poverty Island treasure, (but) it's only a legend until someone digs it up," Bennett said.

According to local folklore, in 1863, during the Civil War, Napoleon III of France sent five chests filled with gold coins to the United States. The gold was destined for the rebellious Southern states in their bid to leave the Union, a cause that France openly supported.

But the South was under a naval blockade. So the French gold was sent to Canada by sea, taken overland to Escanaba, Mich., and then loaded onto a brigantine for the journey down Lake Michigan to Chicago.

From there the treasure was to have been taken to the Mississippi River and shipped to the heart of the South to aid the Confederacy's war machine.

But pirates attacked the ship off the Michigan coast. The crew chained the chests together and tossed them overboard to foil the robbers, according to local legend.

For the past 18 years, Bennett, who owns a diving equipment shop in Wauwatosa, Wis., has spent his free time poring over old nautical charts and books in remote libraries, searching for the treasure.

He and his four-man diving team have explored two square miles of lake bottom four miles north and west of Poverty Island.

The treasure is thought to be about 50 feet below the lake's surface, in waters that rarely warm to more than 40 degrees Fahrenheit at any time of year and are crusted by thick ice in winter.

The 14-foot sub, built at a cost of $25,000, will allow four men to remain submerged in a "warm water envelope" for four hours at a time, increasing their effectiveness in the chilly depths.

The 580-pound vessel fills with water when submerged. An electrical heating system keeps the water inside warm and prevents the divers from losing too much body heat.

In his explorations so far, Bennett said, the cold water had severely reduced the number of hours each day the divers could remain under water.

The coldness of the lake was amply illustrated a while back when divers brought a shipwreck to the surface. When the ship sank 100 years ago, a pot of chicken was boiling on the stove. A vacuum formed and because the water was near freezing, the chicken was still considered edible a century later.

Besides providing warmth, the submarine has tanks built into its superstructure that will hold nearly 100 cubic feet of air for each of the four divers, giving them extra capacity beyond what they carry on their backs.

The British Ministry of Defence has acquired and implemented a device constructed around a specialized Oceano Instruments release, a Telecommand Unit, and associated equipment, in connection with an underwater test vehicle called "MOBY."

"MOBY" is a buoyancy-propelled vehicle built by Rockwell of America to be used in a comprehensive program of tests. It includes two instrumentation pressure-resistant spheres built by Slingsby Engineering Ltd, of England.

During the trials, "MOBY" is pulled down to a pulley mounted on a large seabed sinker weight on the seabed. "MOBY" is released for a run to the surface by an electrical signal to an Oceano MR 120 CS Mechanical Release. To release the pulley to the surface, a system can be actuated using acoustic telecommand. This system comprises an Oceano XT 121 Explosive Trigger connected to a Honeywell Leafields heavy-duty explosive bolt.

Using a TT 201 Telecommand Unit and Dunking Transducer, the support ship can range on the XT 121 to ensure it is at a safe stand-off, and may send a command to arm and then fire the explosive bolt.

"MOBY" was used for its first test program in Europe during the late summer of 1984.

The "MOBY" trials constitute an additional demonstration of the reliability of the Oceano Instruments triggering system. The U.S. Navy previously carried out comprehensive and successful trials to try to mis-trigger the TT 201/XT 121 Acoustic Explosive Trigger system, before approving it to be placed by a manned submersible. It was then used together with Jet Research Center "Thermol" torches to cut the mooring chains of the Ocean Thermal Energy Conversion (OTEC) pipe off Hawaii in 1982. The XT 121 has also been incorporated into the "Jetlink" rig anchor release system by JRC of Arlington, Texas (see "Oceano Outlook," Vol. 2 No. 1).

The Releases described here are part of the widest range of underwater Acoustic Release Transponders manufactured anywhere in the world. All such Transponders may be used with interchangeable Release Hooks rated from 2 to 90 tons. The XT 121 is a modified unit in which the Mechanical Release motor has been replaced by a detonator firing unit which outputs an electrical pulse.

UPHOLDER CLASS SSK

Britain's Royal Navy once again has diesel-electric submarines under construction at Vickers Barow yard. Given the designation, Upholder Class, it is similar to the Vickers 2400 class design which is offered for export sale.

It is fitted with 6 tubes to handle 21-inch diameter weapons including torpedoes, Harpoon-type missiles and mines. It is also equipped with a 5-man diver lock-out chamber. Design diving depth is over 200 meters. Normal crew will be 44.

This 70 meter (230 ft.), single screw boat is propelled by 2 motors in a common frame. There are two diesel generators and two banks of lead-acid batteries. A continuous transit of 7,000 nautical miles or an operating radius of 2100 nm (28 days in the patrol area) can be achieved. As a diesel-electric sub employing the latest sound-quieting technology, it will run with a greatly reduced noise signature.

Vickers also has designed the 550 Class diesel boat which is smaller and is designed for coastal defense and medium-range patrols and the Piranha, a small surveillance, attack submarine. A unique feature about the latter is that it is fitted with two 20 man chariots armed with mines and limpet mines. The chariots can be launched and recovered while Piranha remains submerged. Combat swimmers and chariot operators are released and recovered through a lock-out chamber. These 2 submarines are being offered to the Royal Navy and for export sale, but presently remain in the design stage.

Refitted *Pisces 2* Joins Research Submersibles' Fleet

Joining in an underwater survey and filming expedition of the Imperial Japanese battleship Yamato, Research Submersibles Ltd.'s newest fleet addition won't see home-base duty (Georgetown, Cayman Island, British West Indies) until some time this month, according to marketing manager Alan Whitfield. The new submersible, *Pisces 2,* was added after a refitting and special ABS survey in Scotland. Then it was immediately air-lifed to Japan for the filming exercise.

Pisces 2 is a three-man, 1000 meter observation submarine built by HYCO in 1969. In Japan, the vehicle will be operated by RSL crews from a support ship provided by Fukada Salvage & Marine Works.

Whitfield said the sub has been outfitted with OE1335 TV cameras supplied by Osprey Electronics Ltd. (Aberdeen, Scotland) and an Underwater & Marine Equipment Ltd. (UMEL) 35 mm still camera.

Japanese television company, NHK, is producing the documentary about the *Yamato,* which was sunk in the East China Sea on April 7, 1945. The flagship of the Japanese Imperial Navy, the 72,000-ton battleship carried nine 18-inch guns and 63-centimeter armor plating. She was attacked and sunk by 300 U.S. warplanes while enroute to Okinawa.

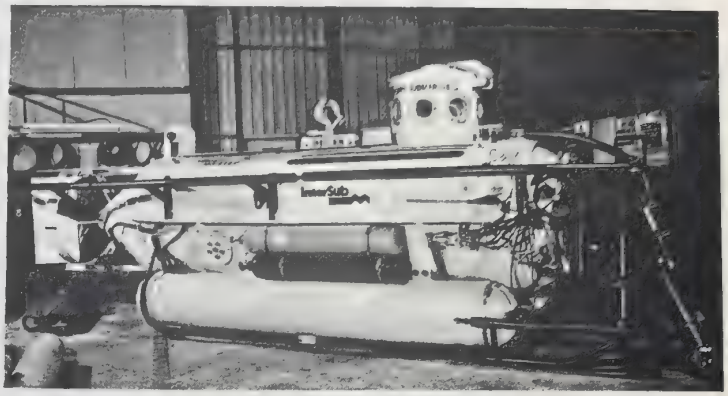
Sonat Subsea And NICOR Offer Underwater Services In The Gulf Of Mexico

Sonat Subsea Services Inc., Birmingham, Ala., and NICOR Marine Inc., New Orleans, La., have announced that they have entered into a cooperative agreement to offer underwater services in the Gulf of Mexico. A NICOR Marine Vessel has been modified to accommodate Sonat Subsea saturation diving and remotely operated vehicle equipment and personnel.

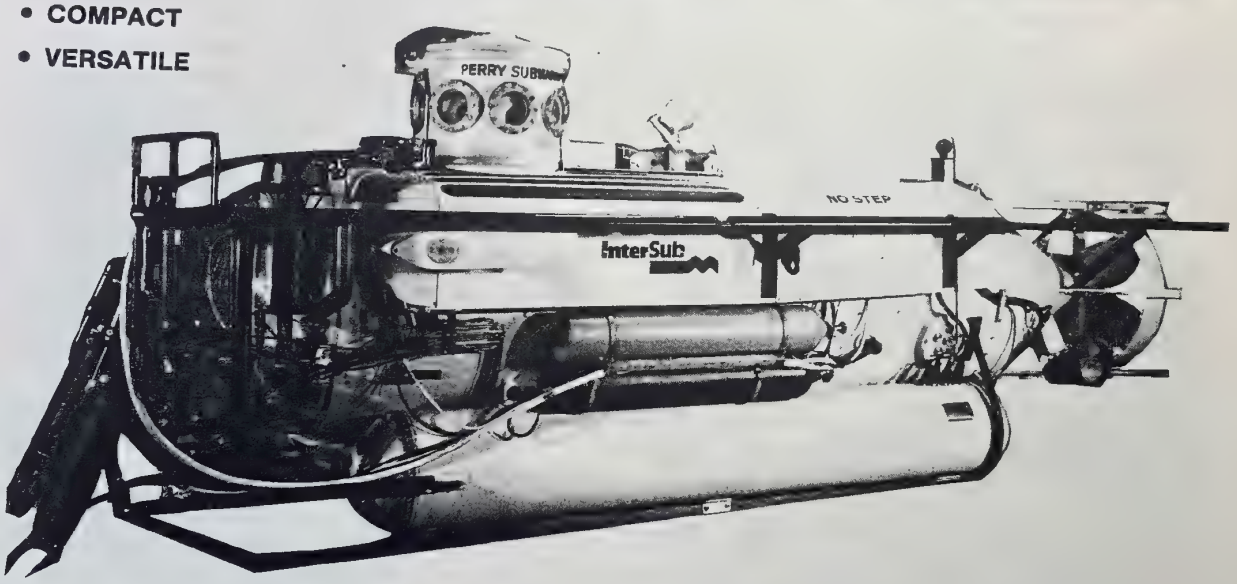
S & H Diving Corporation, the U.S. operating division of Sonat Subsea Services, and NICOR Marine will provide these sophisticated diving services via the 216-foot diesel-electric powered M/V Nicor Subsea.

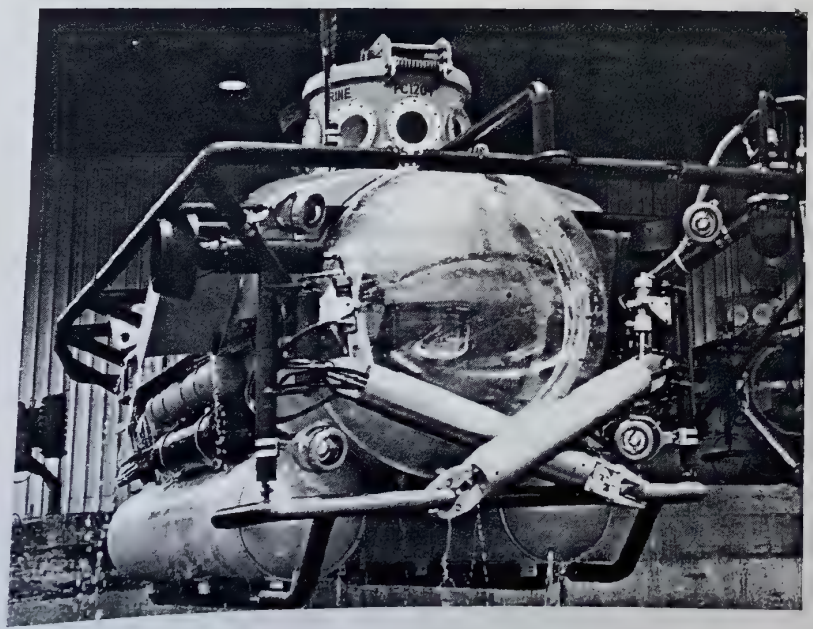
PERRY
PC-12
SUBMERSIBLE

A 2-Man, 1200-FSW-Rated Subsea Work Submersible



- **COMPACT**
- **VERSATILE**





- **Crane Weight: 8 tons**
- **Speed: Up to 3 knots**
- **Typical Bottom Time: 8 hours**
- **Outfitted for survey and inspection of pipelines and offshore drilling rigs**
- **Manipulators available for many repair tasks that would normally require divers**

PERRY OCEANOGRAPHICS, INC.

Federal court ensures Fisher's rights to $400 million sunken Spanish booty

KEY WEST, Fla. (UPI) — A federal judge has given the exclusive rights to a $400 million sunken treasure to Mel Fisher, who spent 16 years finding it, and dismissed a rival treasure hunter's claim to the booty from the Atocha.

U.S. District Judge Sidney Aronovitz, after two days of hearings, dismissed an admiralty claim filed by Richard Lightner that overlapped part of a claim area being worked by Fisher's Treasure Salvors Inc.

Aronovitz did not mince his words yesterday in ruling against Lightner.

"He is doing nothing but attempting to come in on the Atocha wreck site," the judge said. "I am satisfied he is simply trying to take some of the finds of the Atocha."

Fisher and his divers spent 16 years and millions of dollars searching for the scattered wreckage of the Atocha, a Spanish galleon that sank 41 miles west of Key West during a 1622 hurricane while hauling a king's ransom in gold, silver and jewels back to Spain.

On July 20, Fisher's divers found the Atocha's main cargo — 1,200 silver bars and chests of gold and silver coins estimated to be worth $400 million.

Lightner, claiming he had found the wreck of another vessel nearby, filed for salvage rights to an area that overlapped some of the Atocha wreck site.

Aronovitz, in addition to ruling against Lightner, expanded Fisher's claim area from 13½ square miles to 18 square miles and extended his salvage rights, which were scheduled to expire Sept. 26, for another three years.

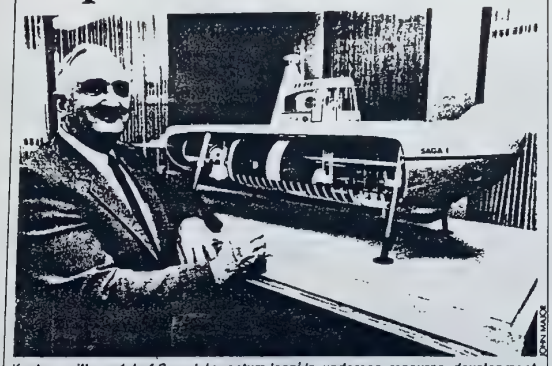
Before the judge ruled, archaeologist R. Duncan Mathewson III told the court the Atocha was a unique "window into seafaring life and times."

"Well over half of the hull is still intact and in very good condition," Mathewson said. He emphasized the area must be excavated carefully.

Mathewson said his three-member team is recording, graphing and photographing every step of the salvage operation and told the judge "I am inviting a number of research scholars to join me."

"This is such a unique time capsule," he said. "A window into seafaring life and times. There is only one Atocha in our galaxy."

Exploration's new era



Kastner with model of Saga I: 'quantum leap' in undersea resource development

Oil and gas companies continually face logistical problems in their attempts to explore the resource-rich continental shelf off the east coast of Canada. Weather and sea conditions are often unfavorable, and supplies must be transported to support vessels stationed above the shelf—a stretch of seabed along the coast reaching depths of up to 650 feet. As well, manned submersible machines can spend only limited time underwater; current models of minisubs, which hold only one or two people, are limited to 24-hour missions. Now, a Canadian and French consortium says it may have a solution: a nuclear-powered submarine designed to settle on the seabed for up to 27 days, carrying as many as six divers for such tasks as exploration or servicing offshore rigs and pipelines.

The consortium, International Submarine Transportation Systems Inc. (ISTS) of Halifax—formed by Port Moody, B.C.-based International Submarine Engineering Ltd., Ottawa-based Energy Conversion Systems Inc. (ECS), Marseilles-based Comex and Infremer, a French-government oceanographic research institute—plans to apply to the Atomic Energy Control Board (AECB) in Ottawa by the end of March for a licence to operate the first nuclear-powered submarine for commercial use. Declared Allan Kastner, vice-president of ECS, which is designing and building the reactor: "We think we are taking a quantum leap in the capability of man to explore and exploit the continental shelves."

The sub, called Saga I and under construction in Marseilles, is due in Nova Scotia by the end of the year to be fitted with its reactor, a relative of the Slowpoke research reactor. Then, said Kastner, the sub will be able to travel thousands of miles from port with a crew of as many as 15 and dive to 2,000 feet. He said the consortium hopes the $120-million project will "open a new era in undersea resource development."

Experts agree that, if successful, Saga N—the completed submarine—could be a breakthrough in underwater research. Dr. Joseph MacInnis, for one, a Canadian pioneer in underwater exploration, is fascinated by the undertaking. Said MacInnis: "What they have in this particular package is duration. That's going to make all the difference." For his part, AECB spokesman Hugh Spence said that "provided the safety-related criteria are met," licensing it for Canadian waters will not be a problem.

ISTS president Ed Dunn said the company hopes to build a clientele in industry and in the scientific and academic communities. For the first time, its users will be able to do extensive soil analysis under ice and even map the seabed. And at least that is a step toward the underwater scientist's goal, as stated by MacInnis: "To get to the bottom and stay there."

—BRIAN JEFFREY STREET with SHARON DOYLE DRIEDGER in Toronto

I.S.E. recently opened a new Research Center I.S.E.R., which includes 35,000 feet of shop and office space and a 40' x 20', 14 foot deep testing pool. This center will carry out I.S.E. R&D, particularily in the development of autonomous remote controlled vehicles-(DOLPHIN & ARCS) and military oriented projects.

The launch of their 72 foot submarine research vessel, the motor vessel RESEARCH I also took place in June.

Additionally, I.S.E. recently delivered HYDRA systems to MARSAT and MONOCEAN, two Brazilian offshore companies, as well as systems to TAYLOR DIVING and HYDROSPACE. Other deliveries—include a TYPE 6 ROSS to Ocean Works of Asia, Tokyo, Japan, a TARS system to Frozen Sea Research and one INSPECTOR to MARTECH.

I.S.E. also assembled a new generation of submarines that will be used at the West Edmonton Mall in September 1985. These four computer controlled, 40 ton submarines measure 33' long, 8' in diameter and conform to American Bureau of Shipping standards. Powered by nickel cadmium batteries, they will transport 24 passengers in a 14 minute journey through the worlds largest indoor shopping center.

An International Satellite Network—SARSAT/COSPAS—Takes the "Search" Out of Search and Rescue.

By Dr. John H. McElroy
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Early in 1985, three Swedish crewmen were sailing a newly built, 12-meter sloop to its new owner in Annapolis, Maryland. About 100 nautical miles north of Bermuda they ran into heavy seas, high winds, thunderstorms and squalls. They began taking on water and soon were forced to take to a life raft.

Fortunately they had an emergency transmitter (an emergency positioning indicating radio beacon, or EPIRB), which they activated by hand. Also quite fortunately, four satellites were "listening" for their signal—three Soviet and one American. The latter is operated by the National Oceanic and Atmospheric Administration (NOAA).

Satellite alert and location data were relayed, via the U.S. satellite and a NOAA ground station at Wallops, Virginia, to the U.S. Coast Guard soon after the crew abandoned ship. Two search planes located the life raft, and a little while later, a Navy helicopter from Bermuda hoisted the men aboard. All three were in good condition.

The combined sortie time of all three aircraft was 23.2 hours; only 2.2 of those hours were logged as "search" time. The satellite location data had greatly reduced the size of the area that had to be searched, and the survivors were quickly found. As Coast Guard Captain M.E. Gilbert said in testifying before the House Committee on Science and Technology last year, satellites "...help remove the 'search' from search and rescue."

By limiting the search area, satellites also reduce significantly the cost of search and rescue operations, as well as the risk to rescuers and equipment by limiting their exposure to bad weather and long, stressful searches.

The first search-and-rescue-equipped satellite, COSPAS-1 (*Cosmos 1383*), was launched by the Soviets on June 30, 1982. Today there are three Soviet and two U.S. spacecraft (*NOAA-8* and *NOAA-9*) listening for distress signals as they circle the earth in polar orbits some 800 kilometers out in space. One of the Soviet satellites is functioning only intermittently.

There are nine ground stations in the northern hemisphere operated by the U.S., Canada, France, the USSR and Norway. The system is now known as COSPAS/SARSAT (SARSAT is the acronym for Search And Rescue Satellite Assisted Tracking. The Soviets' COSPAS is roughly equivalent.)

In its developmental stage the program was a project of the National Aeronautics and Space Administration (NASA) but as of March 1985, management was signed over to NOAA. The program's performance to date has exceeded expectations. It has helped save more than 400 lives in Canada, the U.S., western Europe, and on the oceans between Europe and Japan—and the list continues to grow.

The Coast Guard, which is responsible for COSPAS/SARSAT rescue operations in U.S. waters, also has reported reduced flight times and significant annual savings for ocean rescues. In the same hearings, Capt. Gilbert discussed a single, unsuccessful sea search that cost as much as $2 million (1985 dollars). While many cost far less, the Coast Guard launches more than 60 sea searches a day.

Total U.S. investment in this program to date has been $30 million, an amount likely to be recouped in flight time savings in one to two years or less.

When a vessel capsizes or an airplane crashes, an emergency transmitter is activated either automatically (airplane) or manually (vessel). The device transmits a distinct, continuous "wow, wow, wow" signal that, by international agreement, has replaced the older "SOS" distress signal. The new signal provides both an immediate alert and a homing sound to lead rescue forces to the actual site of the emergency.

Location of the emergency is determined by measuring the Doppler shift in signal frequency caused by the rapid movement of the satellite relative to the transmitter. This information is computer analyzed and passed on to the COSPAS/SARSAT Mission Control Center at Scott Air Force Base, Illinois, from where it is relayed to one of twelve rescue coordination centers—operated by the Air Force and the Coast Guard—covering all 50 states.

Current emergency transmitters were not designed for satellite detection. To increase the capability of the COSPAS/SARSAT system, the participants have developed and are now testing for both marine and aviation use a more effective, second-generation transmitter that operates on the 406 MHz frequency, instead of the 121.5- and 243-MHz processors.

Test results show that the new frequency—with a sophisticated instrument system built around it—is far superior to the 50-year-old 121.5 signal band. The new model transmitter is a considerable improvement over current designs and offers a number of significant advantages. The first is global coverage. Unlike the current system, which operates in real-time and requires that the emergency transmitter and a ground station both be

At its first meeting in Seattle last month, the COSPAS/SARSAT Steering committee (Canada, France, the Soviet Union, and the U.S.) voted to adopt the 406 MHz frequency for operational use.

The current COSPAS SARSAT concept calls for four spacecraft in polar orbits spaced at equal intervals around the earth to give optimum coverage and to reduce waiting time between satellite passes over any particular point to a minimum. This concept was endorsed when the four partner nations signed an agreement in Leningrad in 1984 that the U.S and the Soviet Union would each maintain two search and rescue platforms in orbit at least through 1990.

SeaMARC gazes into depths

By Barbara Hastings
Advertiser Science Writer

The SeaMARC II sits aboard the UH research vessel Kana Keoki.

It was back in the 1970s and marine geologists were getting pretty frustrated with the thin ribbons of data available about the sea floor.

The Navy had a device that gave wider swaths of information on the ocean's depths, but as with many military things, it was classified. The U.S. government decided a U.S. university needed to have a mechanism that would record wide bands of bathymetry (ocean depths) and announced it would fund such a venture.

"The University of Hawaii was eliminated off the bat," says Donald Hussong, a marine geophysicist at UH's Hawaii Institute of Geophysics.

It may well have been a fortuitous turn of events because while the Scripps Institution of Oceanography got the federally funded device, the University of Hawaii ended up with a better mousetrap.

The Scripps instrument records just bathymetry — that is, just measures the depths of the ocean. The UH device, the SeaMARC II, gives the equivalent of a topographical map of land — the depths and contours of the ocean's floor.

Hussong explains that despite the federal rejection, the geophysics institute was very excited about a seafloor measuring device — so it got one on its own.

A private company, International Submarine Technology, had developed a sonar system to find the Titanic.

The company decided its device could be adapted for other uses, and "they interested us in a cooperative venture — a system off a relatively small boat," says Hussong. And so, the half-million-dollar SeaMARC II was born, with a bit of funding from here, and a bit of funding from there.

"It took a strong commitment from UH and the Research Corporation (of UH) that they would see us through the periods of spending money faster than we were bringing it in."

The SeaMARC II is the only device of its kind — it gives both the depth measurements and the sonar images. And today, it does bring in money, at least to pay expenses.

The National Science Foundation heavily funds SeaMARC II and the Navy throws some money in the pot.

And for work on the Juan de Fuca Ridge (an undersea area whose control is in dispute between the United States and Canada), the Canadian government has paid the bill.

Hussong himself is currently involved in nine federal grant projects, totaling about $2.5 million — and much of the work involves the SeaMARC II. His work has just won him the ARCS Foundation honor of Hawaii scientist of the year. ARCS is a women's organization which promotes science through scholarships and grants.

The scientists at the geophysics institute call the SeaMARC II "the tow fish." That's because it's fish-shaped and is towed behind the Manoa Wave.

Hussong, fresh off the boat, which just finished work off South America and is headed back for an early July homeporting here, explains a little of how the Sea Marc II works.

(The redesigned Manoa Wave, by the way, is on its maiden voyage. Built in the early 1970s, the ship was cut in half and lengthened to 212 feet last year, and "is probably the nicest boat in the U.S. academic fleet," says Hussong. It's comfortable, but that's not Hussong's criteria for nicest. Nicest to these geophysicists means "a lot of lab space.")

The SeaMARC II isn't magic, and it doesn't represent any great technological step, says Hussong. "It's just the buckling together of a lot of technological things." He says they've basically built a lot of small special computers, and to successfully operate the system takes a lot of "sophisticated high-speed processing."

The tow fish has two 17-foot long arrays of hydrophones ("like underwater speakers; ceramic crystals," Hussong says) that send out sound and listen for sound.

The sound that bounces off the ocean bottom and returns is recorded on paper and the intensity of the returning noise "gives you the characteristic of the sea floor," he says.

For instance, muck or sediment does not send back sound as strongly as rock.

It's a long-range side-scan sonar system — that means the hydrophones are pointed in such a way as to collect information on a 30-kilometer (18.6-mile) swath of ocean floor.

By towing the SeaMARC II back and forth in a grid-like pattern, the sonar system provides a a sketch of dark and light blobs and patches on the sea floor. Light means sediment, dark means harder surfaces.

Combining this with the bathymetry gives the undersea topographical map, or contour map. This dark

splotch is a hard, but not high, lava flow on the seafloor, this small knot is an undersea volcano, this one a seamount.

From the Juan de Fuca Ridge, there's an image of a seamount being pushed up between two sections of the rift zone — the seamount is formed from the spreading center.

The SeaMARC II was lost in 1,000 feet of water off Oahu last November when a cable broke. It took 11½ hours and the UH's tiny submarine, the two-person Makali'i, to scour the area about 1½ miles off the reef runway before it was found and recovered.

Major projects the SeaMARC II has been involved in include a look at the tectonic plate interaction in the Java-Celebes area, the Canadian work on the Juan de Fuca Ridge, a swing through the Galapagos to look at seafloor spreading, and a study where the Nazca plate is smashing up against South America.

For the Department of Interior, the SeaMARC II has surveyed parts of the Pacific around Hawaii for manganese crusts.

There are other systems, like the one at Scripps, that are more precise on the bathymetric data, Hussong says, "but ours is a lot more useful."

Research Submersibles Ltd. Adds On a New Submarine

Research Submersibles Ltd. of Georgetown, Grand Cayman, British West Indies, has announced the addition of *P-5 (Pisces Five)*, a 6600 ft. (2012 m) deep-diving submersible, to its lease fleet of manned submersibles.

P-5, a three-man observation submarine built by Hyco in 1973, underwent a complete refit in 1983. There are three viewports in the forward pilot's sphere and the submersible is equipped with two manipulators and a SubSea underwater TV system.

Following the trend of ROV operations, RSL is leasing its manned submersibles with a crew, spares, manipulators and photographic equipment—but without support ships—at roughly the same charter rates as their unmanned counterparts. At present *P-5* is targeted for use in marine research, but the company also was studying proposals to put the vehicle into commercial applications in the future.

Introduction

In July of 1980 the Hawaii Undersea Research Laboratory (HURL) was established by a cooperative agreement between the National Oceanic and Atmospheric Administration (NOAA) and the University of Hawaii. HURL is one of five national laboratories sponsored by NOAA's National Undersea Research Program. HURL provides for and supports the development and application of those operational undersea capabilities for which NOAA is responsible in carrying out its ocean related mission. The laboratory primarily supports marine research projects that require data acquisition at depths greater than scuba limits. The major HURL facilities presently consist of the two-man, one-atmosphere submersible MAKALI'I; the Launch, Recovery and Transport vehicle (LRT); the remotely operated vehicle SNOOPY; and, when needed, various leased surface support vessels. The research submersible MAKALI'I is used primarily for projects accepted by a national science review panel which approves and ranks solicited proposals for submersible use. To date, the MAKALI'I has completed over 250 NOAA-approved dives.

The HURL program concentrates its research efforts in the following four general areas:

1) Fisheries
2) Pollution
3) Sea floor properties and processes
4) Ocean technology and services

Research proposals for projects within these and other areas are peer reviewed and selected on the basis of criteria described further in this brochure.

Facilities and Equipment

Makai Research Pier

The HURL operations center is located on the Makai Research Pier at Makapuu Point. The center is on the southeast coast of the island of Oahu approximately 15 miles from the city of Honolulu. The pier is 183 meters long with open ocean access and support vessel mooring areas. Located on the pier is the submersible shed which also houses the operations office, diving locker, recompression facility, machine and electronic shops, and high-pressure air station. The HURL administrative office, data archive, and laboratories are located on the University of Hawaii-Manoa campus in Honolulu.

The Submersible MAKALI'I

MAKALI'I is a two-man, battery-powered, one-atmosphere submersible. It is 4.77 meters long and has a pressurized capsule 1.54 meters in diameter. It carries a pilot, one observer, and payload of up to 95 kilograms. Normal operating speeds range from 1 to 3 knots with a dive duration of 4 to 5 hours and life support for 72 hours. The MAKALI'I has been certified by the American Bureau of Shipping for a maximum operational depth of 366 meters.

Equipment carried by or used in conjunction with the submersible includes:

1. hydraulic manipulator and cutter
2. sample storage baskets
3. an internal color camera with zoom lens; a choice of external color or low-light black and white video cameras; and VHS recorder with video monitors
4. running and flood lights
5. 35mm still camera and strobe
6. current and temperature meters
7. environmental monitoring package for continuous recording of depth, temperature, salinity, conductivity, oxygen, and solar radiation
8. dictaphone tape recorder
9. water samplers, sediment grab samplers and box corers
10. collecting system for small, soft-bodied organisms
11. directional antenna and pingers
12. shore-based support vessel tracking system
13. submersible tracking system

The HURL staff works closely with scientists to provide any combination of the equipment for the successful completion of their research effort. The staff is also willing to design or modify equipment to satisfy the specific needs of scientists.

PISCES V TO HAWAII

Research Submersibles Ltd. of Georgetown, Grand Cayman has just entered into a lease/purchase agreement with the Hawaiian Undersea Research Laboratory (HURL) at the University of Hawaii for Pisces V, RSL's deep diving submersible. HURL is one of 5 national laboratories sponsored by NOAA's Office of Undersea Research. Pisces V, a 3-man, 3000m submersible, is now based at HURL's operations center on the Makai Research Pier at Makapuu Point on the south east coast of Oahu. Pisces V has five times the diving range of HURL's present submersible and thus its acquistion will greatly enhance the research capabilities for NOAA's Pacific based program. Pisces V will enable scientists to explore the mineral rich crusts on the seamounts west of the island of Hawaii, Loihi, an active submarine volcano south of the Big Island and the rich sea life and environment along the Hawaiian ridge.

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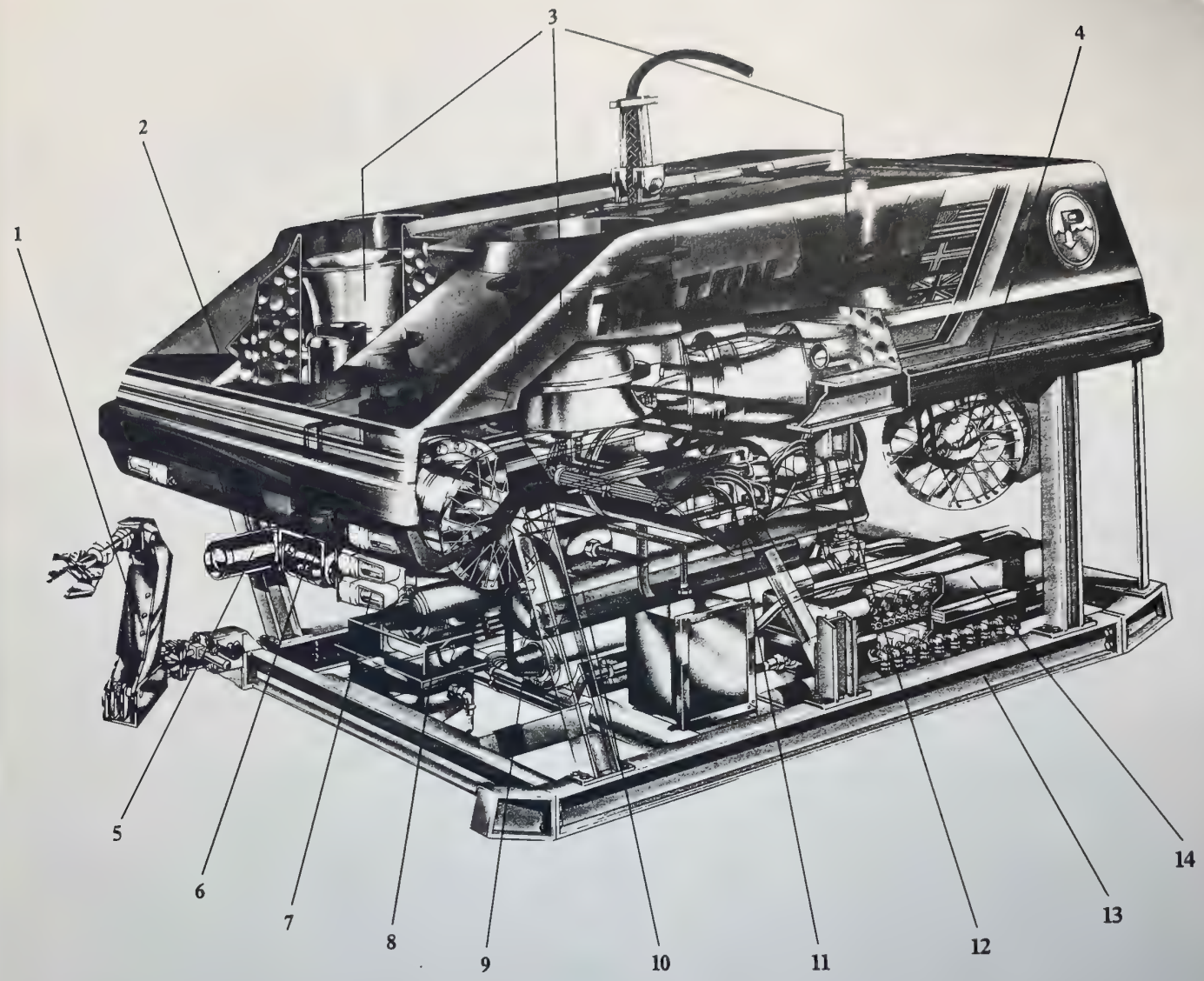


1. The Perry Hercules manipulator is a five-function electrohydraulic rate-controlled manipulator. Its compact size and wide range of movement are perfect for jobs where space is limited but work requirements are great.

2. The standard flotation module is syntactic foam, rated to a depth of 1,000 meters (3,300 ft). Optional depth packages available for 1,520 meters (5,000 ft). The flotation module is covered by a fiberglass skin for impact protection.

3. Three vertical thrusters each provide 180 lb thrust for extra front-end lift and pitch-and-roll control.

4. The two rear horizontal thrusters rated at 450 lb thrust each, are angled at 25° for enhanced control and for uninterrupted thruster flow-through.

5. The standard vehicle camera is a SubSea Systems, Inc., CM-8 black and white ⅔-inch Vidicon tube TV camera with an f1.7, 80-mm lens, providing 65° diagonal viewing area. A usable picture can be obtained at 0.2 foot-candles.

6. The standard pan-and-tilt unit is a MERPRO 1053, a 1,000-psi hydraulically powered unit with position feedback and servo control. Pan is plus or minus 135°. Tilt is plus or minus 90°. Rate is greater than 20° per second.

7. Vehicle lights are four ROS Ultralites, rated at 250 watts each. Extra lights are available as options.

8. Hydraulic manifold for manipulator(s) control contains seven solenoid valves.

9. Hydraulic Power Unit(s). The vehicle can carry either single or dual 25-horsepower units for a total of 50 horsepower. The work package also can accommodate one or two of the 25-horsepower units for a total of 100 hp at the vehicle.

10. The instrument power canister contains the 1,200 VAC step-down transformer and regulated supplies at 120 VAC and 24 VDC, along with dimmers for the vehicle lighting system, GFD circuitry and subsystem isolation relays. It has rapid-access closures on each end and slide-out-tray access for maintenance.

11. The control system canister contains the vehicle control and data telemetry system in a pressure vessel of the same design as the instrument power canister.

12. Auxiliary canister provides a 1-atmosphere housing for customer-added equipment. It has built-in access to vehicle power and control system, with spare wires and input/output capabilities that are already mapped through the system and tied in to the operator control console.

13. Frame is a hybrid of welded aluminium I-beam and schedule 80 pipe. The I-beam protects the flotation-pipe portion of the frame. The frame is unpainted to reduce natural corrosion, which tends to accelerate where coating damage occurs.

14. The main hydraulic manifold for maneuvering and spare vehicle function includes eight servo valves with space for four solenoid valves.

Triton is a new remote-operated vehicle that combines compactness and agility with exceptional versatility and carrying and operating capacity for work packages. No other ROV in its price and size range can match Triton's power, payload, and control system capabilities. Although the vehicle design is new, all of the subsystems and components are proven and can be configured in an almost infinite number of ways to meet unique technical or commercial requirements. Triton, therefore, offers the reliability and serviceability of a standard vehicle with the functional advantages of a custom vehicle.

Work Package Adaptability

Triton is designed to carry work packages for a wide range of operations, including drilling rig support, production platform maintenance, subsea production system maintenance, and general survey and inspection. The vehicle can carry and maneuver work packages larger and heavier than itself: up to 3.62 cubic meters (128 cubic feet) and up to 2,041 kilograms (4,500 pounds). The vehicle's rectangular footprint provides a generous frame area for work packages, and the outer I-beam framework makes it easy to field-install packages by welding, clamping or bolting.

Power for work packages is provided by either one or two 25-horsepower Hydraulic Power Units (HPU's), depending on requirements. These HPU's, when combined with HPU's aboard the Triton, provide up to 100 total hydraulic horsepower at the vehicle.

Triton makes it extremely easy to establish controls for installed work packages. A separate control canister, dedicated to work packages, is prewired to the main control canister and is ready for work package interface using either direct wire or multiplex or both. In addition, the computer control system contains built-in pages for programming work package operations, and the computer color graphics can be reprogrammed to represent the installed work package.

Triton provides control and telemetry capacity for even the most sophisticated work packages: 16 digital channels up, 40 digital channels down, and 24 analog channels up, 24 analog channels down, all at update rates of 15 times per second. A standard Triton vehicle's control capability exceeds foreseeable work package requirements; it is equivalent to controlling all of the following simultaneously (in a hypothetical situation):

- one spatially correspondent manipulator with force feedback
- one three-function grabber
- one four-function grabber
- one five-function grabber
- four bi-directional valves
- cable cutter
- five color SIT low-light cameras (three displayed simultaneously)
- one auxiliary servo-controlled pan-and-tilt unit
- CP probe
- still camera/strobe unit
- transponder
- digiquartz depth
- side-scan sonar
- obstacle avoidance sonar
- Innovatum pipe tracker
- Rovscan thickness measurement device
- sub-bottom profiler
- dual-scan profiler
- auxiliary temperature and pressure sensors

Vehicle Versatility

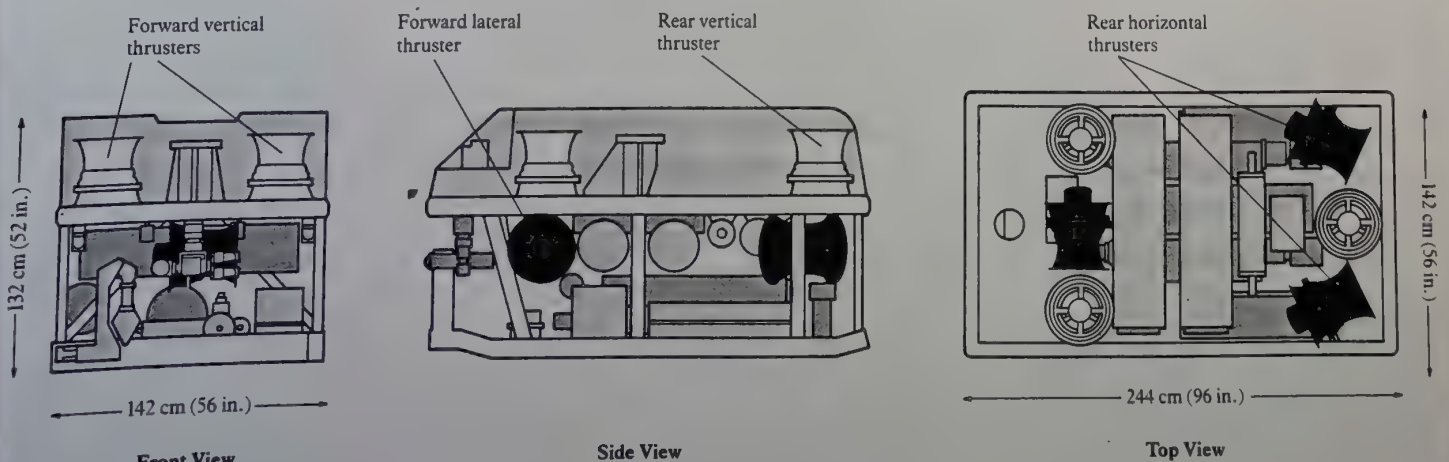
Within its basic, compact framework, Triton is an extremely flexible modular design that offers a menu of equipment choices. Some of these choices are:

- Either one or two 25-horsepower Hydraulic Power Units (HPU's) on the vehicle (the work package can also carry one or two HPU's).
- Standard vehicle buoyancy is 227 kilograms (500 pounds) in addition to all standard equipment. Options are available for heavier payloads.
- The standard flotation package is rated for 1,000-meter (3,300 feet) depths. Optional packages are available for depths to 1.500 meters (5,000 feet).
- The forward section can be easily configured and outfitted to exact owner requirements.
- The vehicle is available with either one or three vertical thrusters.
- The vehicle can be operated with or without a Tether Management System (TMS).
- Various system configurations are available (see back cover).

Control and Maneuverability

Triton's compact size and streamlined envelope minimize drag for increased speed and make it easier to penetrate complicated structures. Adding to its maneuverability is a unique thruster arrangement that uses three vertical thrusters and three horizontal thrusters. The two aft horizontal thrusters are angled at approximately 25°, providing uninterrupted thruster flow-through in both forward and reverse, with minimal restriction on equipment layout. The angled layout also provides the equivalent of two lateral thrusters when both aft thrusters are powered in opposite directions. Independent control of the aft thrusters also provides coordinated lateral and yaw thrust. With two vertical thrusters forward,

These three views illustrate the optimized equipment layout on Triton vehicles. Note that none of the equipment impedes flow-through of any of the six thrusters.



Sub closer to India jet's 'black box'

ASSOCIATED PRESS

CORK, Ireland — A submersible robot operating 6,700 feet deep in the Atlantic homed in yesterday on a piece of wreckage that could contain at least one flight recorder from a crashed Air India flight, Indian investigators said.

As the search for the two black boxes narrowed, a sophisticated U.S. scanner was reported joining the hunt.

"We're satisfied we've got the location," Indian Navy Cmdr. Sunil Culcanni told the Associated Press.

An Irish navy spokesman said the search for the flight recorders had narrowed to a 60-square-yard section of wreckage located 100 miles off the southwestern coast of Ireland.

Bleeps, which could be coming from the recorders, still are being heard.

The flight recorders could hold vital clues to explain what caused the Boeing 747 to crash June 23, killing all 329 people aboard.

The Irish navy spokesman said an Irish vessel, Eithne, towing a 10-ton American sonar deep sea scanning device, arranged to join the search last night.

2nd 'Black Box' Retrieved From Jet

London

A robot submarine retrieved the remaining "black box" from the sunken wreckage of an Air-India jumbo jet off Ireland yesterday, giving investigators an improved chance of discovering why the plane crashed last month, killing 329 people.

Sunil Kulknari, the leader of an Indian investigating team, said that both recovered recorders were intact. The flight recorder recovered yesterday contains information on the aircraft's speed, altitude and heading. The cockpit voice recorder was brought up on Wednesday.

Kulknari said the recorders will be flown to Bombay for study.

Pierre de Niverville, the chief investigator for the Canadian Civil Aviation Safety Board, said it could take several weeks to decode the recorders.

The Boeing 747 was en route from Montreal to India when it plunged into the Atlantic.

The Canadian expert warned that the tapes may not show anything.

He said, "If there was a sudden electrical failure, they would give us nothing, since they operate off the plane's power system. But if the plane took some time to break up, then we should get quite a bit of information, such as the reactions of the crew members, the sounds of the engines and any communications with ground control."

As to the cause of the disaster, some officials believe a bomb was planted aboard the plane, but others suggest that the plane may have been disabled by a structural failure or human error.

New York Times

Undersea Robot Sleuth

New York

The deep-diving unmanned submarine that retrieved the voice and flight data recorders from the wreckage of the Air India jumbo jet off Ireland is a robot of many talents.

Most of the time it works on undersea telephone cables, but it has photographed a crashed helicopter in the ocean off Norfolk, Va., and examined rockets that sank off Cape Canaveral, Fla.

Now the remote-controlled Scarab, has plunged deeper than it had ever gone, and scored the most impressive achievement in its five years of operation.

Although many small submarines are used in scientific exploration and offshore oil operations, they normally have crews and cannot stay submerged for long. Few of them can go to depths of more than a mile or maneuver over extensive stretches of the ocean floor.

The telecommunications industry wanted a durable and versatile craft to deal with the costly problem of damage to undersea cables, primarily from the trawling lines of fishing vessels on the continental shelves.

Scarab, for Submersible Craft for Assisting Repair and Burial, was developed by Bell Telephone Laboratories at Holmdel, N.J., and introduced in 1980. It was modeled after the Navy submersible Curv, which is used to recover torpedoes and other ordnance.

There were two identical Scarabs, each weighing 6300 pounds and the size of a small truck, available at the crash site in the North Atlantic. One is owned by Transpacific Communications Inc., an AT&T subsidiary, and the other by a consortium of British, French, Canadian and American companies.

The craft were designed to operate normally down to depths of 6000 feet. But engineers had allowed for a margin of safety so there was little doubt that the Scarab could withstand the pressures of 6700 feet, where the plane wreckage lay.

The Scarab that recovered the voice recorders was operated remotedly from a control room on its mother vessel, the French cable ship Leon Thevenin. A 10,000-foot umbilical cable linked the two, carrying electrical power and commands to Scarab and sending back data and television signals.

Three people control the Scarab. One person operates the propulsion controls, firing electrical and hydraulic thrusters to maneuver the craft. Another operates the craft's television cameras and jointed mechanical arms. A third person tends the craft's minicomputer.

Last week, one of the crafts began searching a corridor 10 miles by 1 mile where investigators believed the plane wreckage would be. Searchers had by then begun to despair of finding the wreckage.

For several days Scarab's sonar failed to pick up any of the pinging signals from the plane's two flight data and voice recorders. Only after engineers adjusted the sonar so it could detect signals at a slightly higher frequency did the robot hear them.

New York Times

How the Black Boxes Were Retrieved

Much was written in the public press and broadcast in the electronic media when the Air India 747 crashed and sank 100 miles southwest of Cork, Ireland. The accounts of the retrieval of the "black boxes"—the cockpit voice recorder and the flight data recorder—were technically flawed. Here is a brief account of those operations which featured the Ametek Straza Division unmanned submersible *Scarab I.*

Scarab I was aboard the French cable laying ship *Leon Thevenin* in the port of Brest, 300 miles from the crash site. The submersible is owned jointly by AT&T Communications and the British, French and Canadian communications companies.

Air India chartered the *Scarab I* system. At about the same time *Scarab II,* wholly owned by AT&T Communications, was chartered by the government of Canada and placed aboard the Canadian Coast Guard vessel *John Cabot,* which sailed from St. John's, Newfoundland, with a crew from Ametek's Eastport International subsidiary in Upper Marlboro, Maryland, which operates that submersible for AT&T under contract. Both submersibles were built in 1976 by the Straza Division in El Cajon, California, adjoining the east side of San Diego.

Scarab I arrived first at the crash site July 2 and towed a U.S. Navy hydrophone and narrowed the search to a circle. The depth was 2,040 meters (6,700 feet). It was found that *Scarab I's* umbilical cable was too short. That was solved when a Canadian Air Force *Hercules* delivered a 3,050 meter (10,000 foot) cable on July 4. The cable was borrowed from *Scarab II.*

A complication developed when it was discovered that the sub's sonar working near the bottom could not pick up the signals of the black boxes. A British submarine operating near the site discovered that damage had probably altered the black boxes' frequency so that they were transmitting on 39 KHz rather than 37 KHz. The *Scarab I's* crew returned the sonar and the search was on over a track four miles long and one - quarter of a mile wide. One dive lasted 89 hours, with operators working shifts.

Using discrete sonar transponders, the Eastport engineers plotted the wreckage and created a grid which enabled the sub to locate a specific part of the grid, in this case the tail section which carried the black boxes. On July 9 the sub was maneuvered close to the cockpit recorder and grasped the recorder with its manipulator arm. It took two hours to reach the surface with the 50 pound load. Almost immediately the sub was lowered again and soon found the data recorder by following its pinging signal, 500 meters from where the first recorder was found.

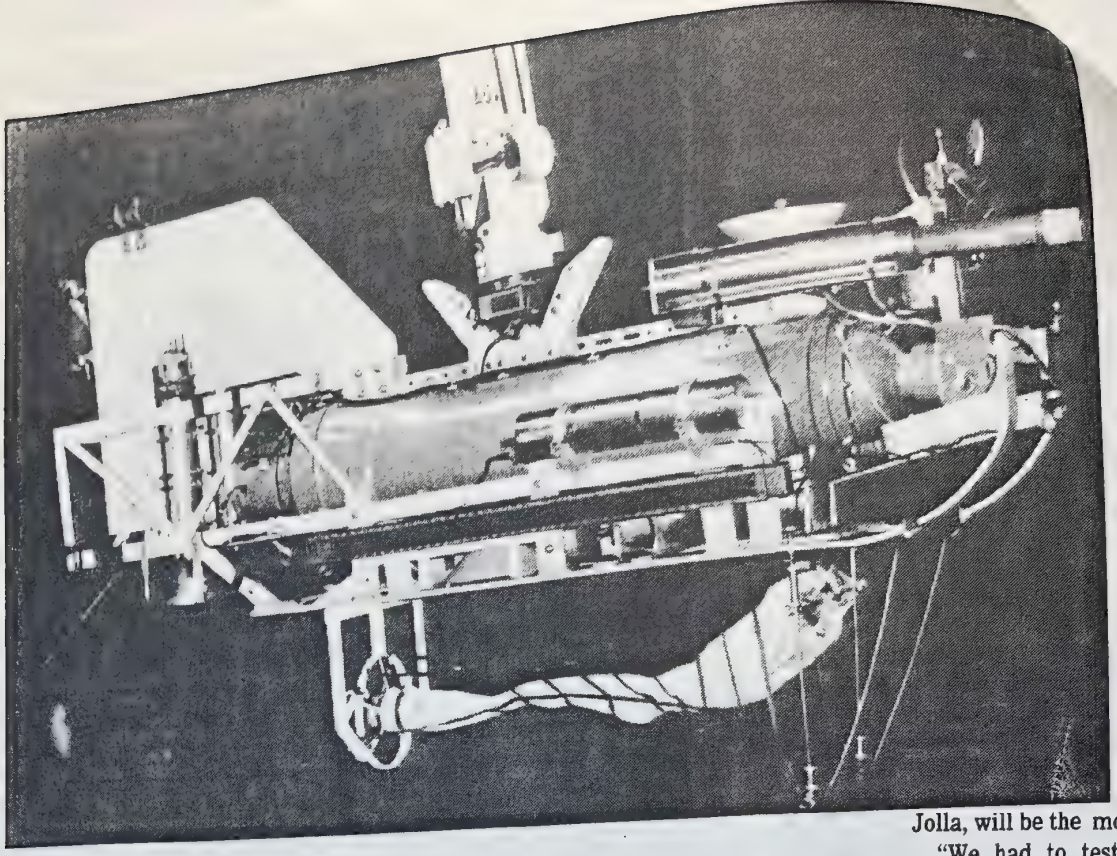
Scarab II reached the site and was chartered by the Canadian government to stay at the site for a month. **L.B.**

The Wave of the Future

Over 150 people turned out to hear John H. McElroy, Assistant Administrator, NOAA, speak at the March 27 luncheon of the newly revived American Oceanic Organization (AOO).

McElroy delivered a thought-provoking talk on the unlimited potential satellites will begin to offer the ocean community over the next 7 years. Some $1.5 billion will be spent on ocean observations from satellites. With increasing frequency and regularity, satellites will be able to provide a data set of wave height, sea-surface temperature, wind speed and wind vectors for the entire world's oceans. By the end of the decade, the European Space Agency will launch a highly sophisticated satellite fitted with a scatterometer, an altimeter and synthetic aperture radar. This will be followed soon after by a similar US version, the Navy Remote Ocean Sensing System. McElroy predicted such sophistication will make valuable ocean data available as frequently as every 6 hours. In addition, data sets will increase from today's 2-4,000 to about 4 million—per day by 1990! NOAA hopes to provide these data to industry for packaging and sale to users.

One anticipated difficulty of the program will be coordinating all the data from the various missions so that it will reach all users in a timely, efficient fashion. McElroy reported this problem is receiving high priority at NOAA and that the US is currently involved in negotiating agreements for US access to ESA data.



Deep Tow is an underseas robot that was used in the search for the sunken luxury liner Titanic.

Realm of robots

By Warren Froelich
Staff Writer

The robots are coming, and maybe even Captain Nemo would be impressed.

Last week, the robot ship Argo found the sunken Titanic, which had languished 73 years in a deep-ocean canyon more than two miles under the sea. Earlier this summer, another robot craft manufactured in San Diego was dispatched to find "black box" flight recorders from a missing airliner.

But these are only the most visible examples of this mechanical population explosion.

Need a tedious job to be done for weeks on end, in the alien environs of the deep sea?

Need that job to be done without complaint, vacation, or even coffee break?

Underseas robots, better known in the trade as remotely operated vehicles (ROV), are the answer.

"Once (the price) breaks the $10,000 barrier, it could be used aboard large yachts as a toy," said Bob Wernli, head of applied engineering with the Naval Ocean Systems Center in San Diego. "They may become very useful for shallow water dam inspections, for tunnels inside nuclear power plants, for academic institutions interested in shallow water research."

It wasn't long ago that these mechanical creatures were but a curiosity, something to be displayed at annual shows for a small band of inventors and entrepreneurs.

But the recent exploits of the two high-tech, deep-sea divers have elevated the field to an international headline grabber.

Last week, the Argo turned on its underwater cameras and allowed viewers around the world to get their first glimpse of the Titanic — down to its place-settings — since it sank in more than 13,000-feet in Atlantic waters on its maiden voyage in 1912.

Ironically, the discovery of the lost ocean liner came on the Argo's maiden voyage.

The craft's first scientific mission will take place this December in a region known as the East Pacific Rise, 21 degrees north latitude off Central America.

The research vessel Melville, operated by UCSD's Scripps Institution of Oceanography in La Jolla, will be the mother ship.

"We had to test it somewhere," said William "Skip" Marquet, senior research specialist at the Woods Hole Oceanographic Institution, near Cape Cod, Mass., and one of the engineers who helped build the submersible.

"It was a large-area reconnaissance vehicle, designed to do that for scientific purposes.

"The Titanic site was suggested as an area where we would have deep ocean and if we got lucky, we might come home with an extra bonus."

Earlier this summer, another ROV called the Scarab fished from the ocean depths two "black box" flight recorders from Air India Flight 182 after the plane fell into the sea off Ireland on June 23.

It was a classic needle-in-the-haystack operation for this mechanical diver, manufactured by Ametek-Straza of El Cajon.

"We got discovered after that," said Jim Snow, Ametek-Straza's director of communications.

To be sure, today's ROV's should not be confused with R2D2 in flippers.

About 400 varieties of ROVs are roaming the seas, many helping out with oil platforms at sea, the laying of telephone cable on the ocean floor, hull inspections and mine sweeping operations.

They come in all shapes and sizes, sometimes equipped with television cameras, mechanical arms or sonar scans. Some are tethered by powerful cables that carry electrical commands and power. Others are simply towed and guided by a mother ship.

Unlike manned vehicles, these new robots often can dive to deeper locations, stay there for longer periods of time and essentially leave the driving to a control room operator, sitting in dry comfort on the surface.

Such an invention might have allowed Captain Nemo, the tortured ruler of Jules Verne's fictional submarine Nautilus, to find time to get some sun.

"He (the operator) sits there in a nice top-side comfortable control room with a cup of coffee there instead of a wet suit," said Wernli, who chairs the ROV committee of the non-profit Marine Technology Society.

But these ROVs are probably just the Model T's of this industry.

Wernli, who also chairs the ROV committee of the non-profit Marine Technology Society, says that untethered, autonomous ROVs — preprogrammed to perform certain tasks — will make up the next generation of underseas robots.

He also foresees cheaper, mass-produced models that could make ROVs even more commonplace. Current pricetags range from $20,000 on up to $1 million.

The development of ROVs began in San Diego as a drawing board toy at the Naval Oceans System Center. Called CURV I, for Cable-controlled Underwater Recovery Vehicle, this first vehicle was designed to seek out and recover torpedoes along sea test ranges here.

In 1966, the submersible became famous after it retrieved a hydrogen bomb that accidentally fell from an airplane into the sea off the coast of Spain. A later model, dubbed CURV III, rescued two men trapped in a diving bell in 1975 near Cork Island, Ireland.

"They had only a few minutes of life support left," said Wernli. "CURV attached the final line and helped raise it from the sea."

From a military vehicle, ROVs began to attract commercial interest in the mid-1970s, particularly from oil companies with large sea platforms which were anchored at depths beyond diver capability.

In San Diego, two companies — Hydro Products in Sorrento Valley and Ametek-Straza — carved out a large share of the ROV market. Today, these companies represent two of the four largest manufacturers of ROVs in North America.

Hydro Products, a division of Honeywell, is the largest manufacturer of ROVs in the world. Today, the company is concentrating its efforts on smaller vehicles for use in shallow water and is working on a mine hunting ROV for the Navy.

The Straza division of Ametek has specialized in larger workhorse vehicles such as the Scarab, an acronym for Submersible Craft Assisting Repair and Burial. Nearly 10 years old, the Scareb was designed to lay underwater telephone cable for AT&T, which in 1976 ordered two of them.

According to communications director Snow, the vehicle was built to withstand pressures from a depth of 6,000-feet, is equipped with TV-cameras, a still camera, a 8,000-foot umbilical cord, two mechanical arms, sonar for search and sonar to help the craft know its position in relation to the sea bottom.

It's roughly the size of a compact car.

The Scorpio, with a sales price of $600,000, followed the Scarab which was designed and built for about $6 million. So far, the company has sold 57 of these craft, which can work at depths of 3,000-feet. A newer model, called the Gemini, will go to 5,000-feet at a cost of about $1 million.

Several research ROV's also are exploring the seas. At UCSD's Scripps Institution of Oceanography in La Jolla, scientists have developed a series of remotely operated underwater vehicles called RUM, for Remote Underwater Manipulator.

RUM III, capable of working at depths of about 20,000 feet and developed by Scripps' Marine Physical Laboratory, will help scientists map the ocean floor with devices that "fly" over the ocean bottom. It will be equipped with underwater TV cameras and lights, a slow scan video system, three thrusters, and side-looking sonar scopes.

"The deep-sea floor has had a growing importance as a source of natural resources and, in the future, is likely to be even more important as terrestrial resources diminish," said Dr. Victor C. Anderson, professor and research physicist at Scripps and one of the principal designers of RUM III.

"The capacity to work on the ocean bottom, over an extended period of time, where divers or scientists in submersibles can only go for a short period of time, means we can do much more deep-sea surveying and investigation to help in the understanding of sea floor processes," he said.

Much of the work behind the RUM came from earlier designs with other submersibles such as Deep Tow, built at Scripps under the direction of Dr. Fred Spiess, director of the UC Institute of Marine Resources located at Scripps.

Construction on the Deep-Tow began in the early 1960s, originally built for submarine searches and ocean bottom mapping.

"Basically, these things are a pressure case with a bunch of electronics in it towed down fairly close to the sea floor," Spiess said. "Towing it is a combination of wires and cable that sends power and control signals down and receives data back up again."

Earlier this decade, Spiess and Columbia University geologist William Ryan were hired by Texas oil millionaire Jack Grimm to search for the Titanic.

A newer submersible system called Searmarc I was built for the search during the summer of 1980; Deep Tow was employed the following summer.

"I wanted to find it, sure I did," said Spiess, now 65. "But I didn't. I must say I haven't been very zealous about pushing to go and do it since.

The Argo, roughly the size of an automobile, follows a similar design to Deep Tow.

It's the first, and larger half, of a dual system developed at Woods Hole by Dr. Robert Ballard, the scientist credited with the discovery of the Titanic. Construction of the Jason, a "flying eyeball" about the size of a large beach ball and of capable of even closer examination of underwater features, is expected to begin later this year.

"Jason will add the capability to permit you to be highly effective after you found something and you want to stop and investigate it in greater detail," said Skip Marquet, the Woods Hole engineer.

Oceans talks here told of artificial gill

An artificial gill that extracts oxygen out of seawater so people and submarines can stay underwater longer was one of the advances described yesterday at the first day of an international conference here.

The gill is one of the many revolutionary changes in marine technology described at the meeting that have opened up previously unreachable depths of the ocean for scientific study.

About 1,000 scientists, engineers and marine produce manufacturers are meeting all week in this ocean-oriented city for Oceans '85, the major international meeting for marine technology engineers. Dr. William Nierenberg, chairman of the conference's advisory committee and director of UCSD's Scripps Institution of Oceanography, said the theme of the conference — Ocean Engineering and the Environment — could signal a change in emphasis for the ocean engineering community.

"I think it's very important that ocean engineers, from the very beginning of a project, have the environment as a primary consideration" in addition to economics and technology, Nierenberg said.

The environment shared the podium with politics at several sessions yesterday, as various speakers blasted the Reagan administration's science funding for oceanography, complained about laws that hinder ocean mineral exploration and worried about the military role in marine research.

Erich Bloch, director of the National Science Foundation, described how military funding for marine science has grown in the past five years so that it is now the dominant source of all federal oceanography research.

The problem, he warned, is that "most of the military research is focused on fairly short-range technology development."

The federal government, he said, needs to shift its priorities back to funding additional longer term, basic research if the United States is to halt its slide into a high-tech world trade deficit.

If 2 percent of the federal money spent on applied research and development were reallocated to basic research, he said, it would free up $1 billion — or 60 percent of the National Science Foundation's budget.

Politics are also a stumbling block to ocean bottom mineral exploration, according to Dr. John Flipse of Texas A&M University and chairman of the National Advisory Committee on Oceans and Atmosphere.

Research into ocean mining for minerals is virtually straitjacketed because there are no laws specifically governing the exploration of deep sea minerals within the 200-mile U.S. exclusive economic zone, he said.

Instead, there is a "turf battle" between the Department of Commerce and Department of Interior over how to regulate it. As a result, he said, no company wants to take the gamble of investing in the basic survey work needed before mining is possible. Flipse is founder of Deepsea Ventures, an ocean mining exploration company.

However, someday the United States may be cut off politically from its source of minerals such as cobalt, which is mined in Zaire, Flipse warned. When that happens, he predicted, Congress will act quickly to write the laws needed to encourage more private development of ocean mining.

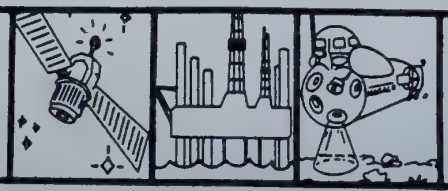
Taylor Pryor, vice president of Aquanautics Corp. of San Francisco, said his firm had successfully developed an artificial gill that can extract oxygen from seawater.

Visions of divers swimming about like fish, free of oxygen tanks, are premature, though, since even with a limitless supply of oxygen, divers are forced to the surface because of cold and fatigue. Pryor said the development could supply a manned submersible with a steady supply of oxygen, or fuel power packs on unmanned equipment that now must be tethered to the surface with power cables.

The gill uses a hemoglobin-like molecule, with a cobalt center, to bind oxygen normally present in seawater. The oxygen bubbles can then be concentrated out of solution and either used for breathing or to power diesel engines or fuel cells.

The firm has a $1.5 million contract from the Defense Advance Research Project Agency, and recently got preliminary approval to go ahead with the project's second stage, in which the gill would be tested during a 25-day dive of an unmanned submersible.

MARINE TECHNOLOGY SOCIETY
HAWAII SECTION



PACIFIC CONGRESS ON MARINE TECHNOLOGY
PACON 86
HONOLULU, HAWAII - MARCH 24-28, 1986

Menard, ocean sciences pioneer, dies

Henry William Menard — a pioneer in charting the ocean floor, former director of the U.S. Geological Society and a presidential science adviser — died of cancer Sunday at his home in La Jolla. He was 65.

Last December, the American Geophysical Union, the largest international society for earth scientists, awarded Mr. Menard its highest honor, the William Bowie Medal, for "outstanding contributions to fundamental geophysics and for unselfish cooperation in research."

He was cited for his work on plate tectonics, his discoveries of the mountain ranges and other features of the sea floor that was once thought to be a flat plain, and his books on the history and sociology of science.

Dr. William A. Nierenberg, professor and director of Scripps Institution of Oceanography, described Mr. Menard as "a pioneer in submarine geomorphology," referring to the science of the nature and origin of the Earth's topographical features.

"He continued to the time of his death to be a major contributor to our understanding of the shape and dynamics of the deep-sea floor," Nierenberg said.

Dr. Roger Revelle, a longtime friend and former director of Scripps, said Mr. Menard's death will leave a void in human relationships as well as in science.

In the 1950s, Mr. Menard became one of the first geologists in the world to use the aqualung for undersea geological mapping, and eventually made more than 1,000 dives. He led, or participated in, 25 deep-sea expeditions.

During the International Geophysical Year, 1957 through 1959, he made the first detailed survey of nickel and copper deposits in the manganese nodules on the deep-sea floor.

In 1965 and 1966, he was a technical adviser in President Lyndon B. Johnson's Office of Science and Technology.

In April 1978, he was appointed director of the U.S. Geological Survey by President Jimmy Carter, and in that position he directed operations in the wake of the Mount St. Helens eruptions in 1980. The next year he returned to Scripps.

One Half Fathom

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DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

AUGUST, 1986

Vol. XIX, No. 2, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operation, and materials in order to further the safe and peaceful progress of man into the deep oceans.

Requests for information or contributions to this NEWSLETTER may be addressed to:

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President & Editor, DSPA
3005 Curie St.
San Diego, CA 92122
(619) 455-6659

or

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2133 Charise St.
Escondido, CA 92025
(619)746-9172

Correspondence relative to membership or DSPA insignia items may be addressed to :

Willis Forman
Membership Chairman, DSPA
3347 Mohican Ave,
San Diego, CA 92117
(619) 275-0294

EDITORIAL NOTES & COMMENTS

The periodic reshuffling of DSPA official duties has been accomplished as is indicated above, plus Larry Shumaker-Vice President. The electoral process was seriously delayed by the lethargy of those Members who were tardy in submitting their ballots.

In general, a dearth of active support by the Members is quite understandably discouraging to your officers. I might add that a flood of letters and contributions from Members would activate your Editor to issue much more frequent NEWSLETTERs.

Dues for 1986 are now overdue if not paid. You should have received a billing from Gerry Shiller. If not please drop Don Saner a line to ascertain your status.

DSPA insignia items obtainable from Will Forman are as follows:

Decals- inside or outside-$1.00 US
Pins - $2.00 US
Patches, cloth- $3.00 US
T-shirts- $6.00 + postage (available with logo on front or back; colors:blue, yellow, or white; sizes:XS, S, M. L, XL)

Rick Boggs wrote in March that he was "missing the old grind" and anxious to hear of any organizations looking for a pilot. Let him know at: S.E. 1020 Ponderosa Drive, Hamilton, MT 59840.

Irene Fager's ONE HALF FATHOM newsletter provides a convenient means for keeping track of who is diving and where. Many pilots and operations people perform a much appreciated service to the "covers" collectors by carrying the covers sent to them by these hobbyists on dives and affixing their cachets before mailing them. It may be something of a bother, but most of these people are bona-fide loyal fans of ours and rate a little consideration as long as they don't overdo the requests. Write to Irene about subscriptions, complaints, information, or whatever at:4004 Bay to Bay Blvd,Tampa, FL 33629.

New Members- Will Forman is hard at work breaking the logjam in the membership process. Seven new Members or Associates have been voted on and approved, and their papers will be in the mail shortly. You may welcome on board Members Richard Barnes, Randy Charlton, Dennis Haines, Thomas Saunders, and Richard Williams plus Associate Members David Panzer and Patrick Smale. . Eleven additional candidates for membership are being voted on.

Larry Megow, my one remaining faithful reporter, sent the following on 6 January 1986.

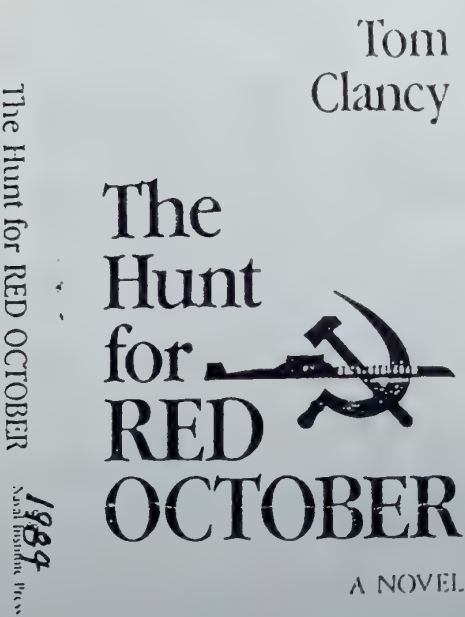
Jan. 6, 1986

A BOOK REVIEW ON

THE HUNT FOR RED OCTOBER

by

Larry Megow



THE HUNT FOR RED OCTOBER (A RUSSIAN NUCLEAR SUB) IS SUPPOSED TO BE FICTION - A NOVEL. BUT THE AUTHOR DESCRIBES IN DETAIL THE INNERMOST WORKINGS OF OUR NUCLEAR SUBS AS WELL AS RUSSIAN SUBS. WHAT'S MORE, THE AUTHOR USES NAMES OF AND DESCRIBES MANY INSTITUTIONS CONNECTED WITH OUR NAVY, INCLUDING:

NAVAL RESEARCH LABORATORY	NORFOLK
NAVAL AIR STATION	BETHESDA
SEA SYSTEMS COMMAND	WOODS HOLE
C.I.A.	

THE AUTHOR ALSO INVOLVES MANY OF OUR MILITARY SHIPS - U.S.S. TRITON, TECUMSEH AND THE SARATOGA. HE INCLUDES A DETAILED DESCRIPTION OF A RESCUE USING THE DSRV ALAVON AND OUR 20,000' BOAT - SEA CLIFF. THE STORY DESCRIBES IN DETAIL A NEW SILENT PROPULSION DRIVE CALLED "TUNNEL DRIVE".

THE HUNT FOR RED OCTOBER IS SUPPOSED TO BE A NOVEL, BUT I THINK ALL OF YOU FORMER SEAMEN WILL FIND IT HIGHLY INFORMATIVE AND INTENSELY INTERESTING. LET ME KNOW IF YOU WOULD LIKE TO READ MY COMPLETE BOOK REVIEW.

Larry Megow

DSPA monthly lunch meetings are held at Tarentino's Restaurant, on Harbor Drive in San Diego, usually on the third Thursday of the month. All members and their guests are welcome. Please notify Worthington or Saner in advance, if feasible; but come anyway. Date of meeting will be changed, if possible, to accommodate visitors from out of town.

Recent lunch meetings were held as follows:

20 March 1986

Jon Engstrom told about the Hubbs Marine Research Center at Sea World in San Diego, California, describing its creation and functioning, including fund raising therefor, Jon's particular contribution to the organization.

17 April 1986

Chuck Nicklin, undersea photographer and owner of the Dive Shop in San Diego, made a presentation on some of his diving and filming experiences. His discussion was enlivened with VCR clips from the TV series"Ocean Quest", featuring Miss Universe 1980 in scuba dives through the Antarctic ice and fantastic footage of humpback whales "singing and choreographing" off Lahaina, Maui, all filmed by Nicklin and Al Giddings.

15 May 1986

LCdr Bruce Bosshard, USN, O-in-C of DRV SEACLIFF, described the 20,000 ft. mods to SEACLIFF, ALVIN's planned '86 operations, this summer's SEACLIFF operations on the Gorda Ridge, with Lockheed's TRANSQUEST as support ship operating out of Eureka, CA.

12 June 1986

This was an organizational meeting attended only by Worthington, Forman, Saner, Shumaker, and Shiller.

17 July 1986

RAdm Brad Mooney, Chief of Naval Research, threw out his prepared speech and talked informally. The Sec'y of the Navy is greatly interested in and supports deep ocean research. The search for a home for TRIESTE continues without success at this point. A support ship for the Navy's deep submersibles is definitely needed more than additional submersibles and is, hopefully, in the works. "Time" magazine will have an issue on deep ocean research in the near future. ALVIN dives on TITANIC now in progress were funded by ONR under the mantle of a test for the JASON/ARGO unmanned systems operated from ALVIN with her manipulators removed. Coordinated dives with the French NAUTILE were called off by the French due to lack of funds. Public relations problems had existed with the French because they sell their news releases while we issue them free, so we had offered them the opportunity to schedule a week of diving prior to ALVIN's arrival on site. There are interesting questions of maritime law pertaining to salvage rights, ownership of the wreck, etc., and the relationship of such laws to situations which may arise in space. There is a commonality of methods and tools between space vehicles and deep submersibles, the latter being more advanced and, thus, influencing the former. After such wide ranging comments, the discussion turned to sea stories. Wish you could have been there!

Quest for the *R.M.S. Titanic*

The Search and Discovery of the Elusive Luxury Liner Involved U.S. and French Instrument, Equipment Makers.

By David M. Graham
Editor

In the best-selling novel *Raise the Titanic!* researchers on a scientific cruise recover a musical instrument from the ocean floor near the suspected site of the sunken luxury liner. Later, author Clive Cussler's hero pilots another research submersible and discovers first the *Titanic's* boilers and then the ship herself.

On September 1, in an unusual case of life imitating art, the nonfictional research vessel *R/V Knorr* dragged the video- and sonar-equipped ARGO a few meters over one of the *Titanic's* distinctive boilers, ending the real-life 73-year search for the "unsinkable" liner's final resting place.

In another coincidence, Cussler, who is also an amateur marine archeologist *(Sea Technology,* January 1982, page 48), plotted his *Titanic* search under the guise of a research cruise aboard a submersible.

The *R/V Knorr*, the 75-meter research ship owned by the U.S. Navy and operated by Woods Hole Oceanographic Institution, was embarked on a joint U.S.-French mission to search for the *Titanic* while—in Woods Hole's case—testing the U.S. Navy's ARGO system.

"We ran smack-dab over a gorgeous boiler," recalls the colorful Dr. Robert D. Ballard, describing the first video sighting. He is head of the Woods Hole Deep Submergence Laboratory that developed ARGO and was chief scientist on the *Knorr*.

From that momentous discovery on, the real-life *Titanic* search rivals the carefully plotted fictional account for excitement. In reality, the mission was a culmination of technological efforts on both sides of the Atlantic. Several U.S. and French oceanographic research instrumentation companies contributed. While the equipment aboard the ARGO is not really revolutionary, Ballard commented, "What's new is how it all fits together" and the software that makes it work.

Several Major Participants

Major contributors included Thompson-Sinatra (a subsidiary of the French-based Thompson-CSF in Paris), which developed the SAR (remote acoustic system) being tested aboard the *Le Suroit*, a research vessel operated by the French Institute of Research for Exploration of the Sea (IFREMER).

On the U.S. side, Colmek Systems Engineering (Salt Lake City, Utah); Benthos, Inc. (North Falmouth, Massachusetts); Klein Associates, Inc. (Salem, New Hampshire); and Preformed Marine, Inc. (Cleveland, Ohio) provided the bulk of the instrumentation and equipment for the ARGO system.

Following the dramatic appearance of the *Titanic* boiler on ARGO's video cameras, Ballard said "We bailed out" and the ARGO was retrieved from its working altitude of about 35 meters to avoid entanglement or damage from the rapidly growing amount of debris. Within moments, the *Knorr's* echosounder beam crossed over what appeared to be the 270-meter long, 53-meter high *Titanic* hull at a depth of nearly 4000 meters.

"We found her with a 25-year-old sonar. Any fishing boat could have done the same," Ballard told a packed news conference on September 11 at the National Geographic Society's Grosvenor Auditorium in Washington, D.C. The society was one of the participants in the mission.

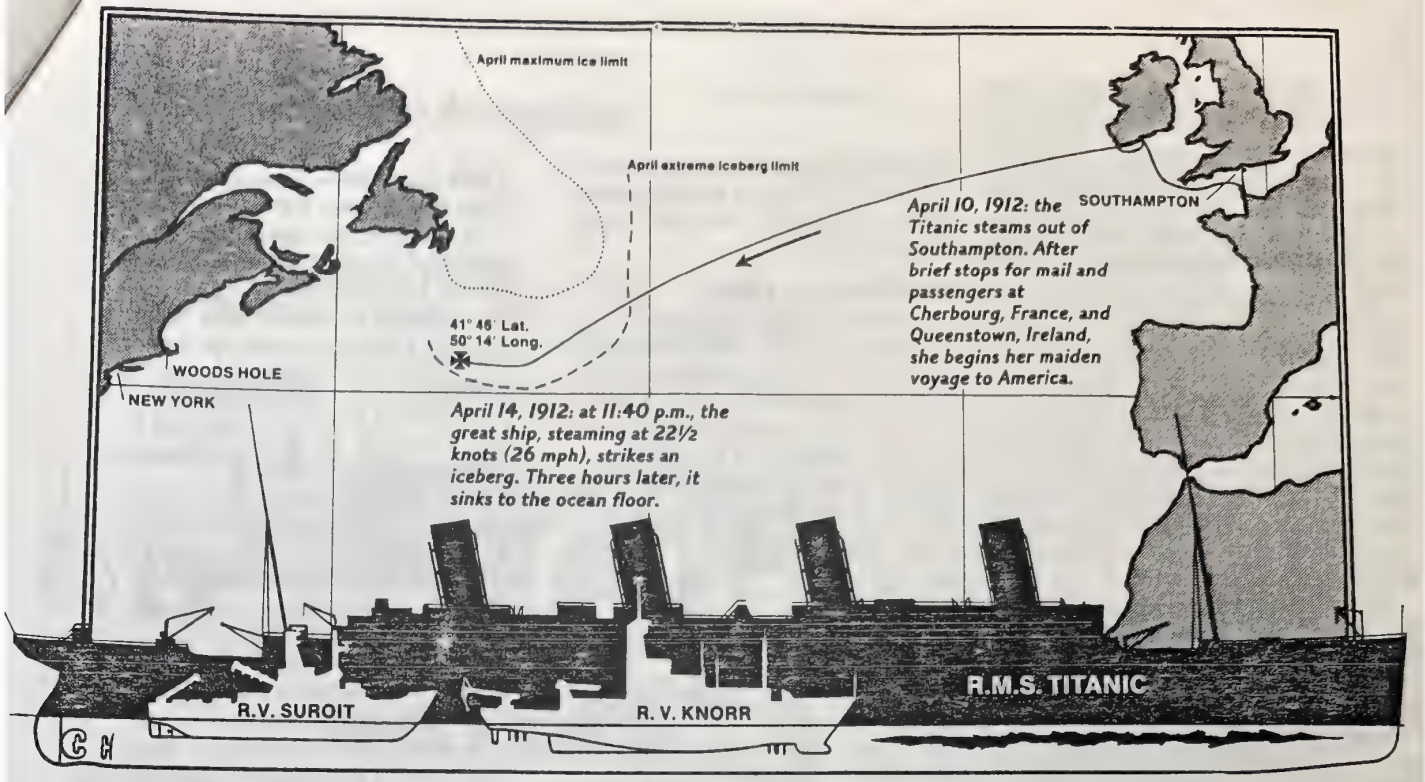
The French SAR and *Le Suroit* could very well have grasped the glory earlier. According to Ballard, the IFREMER vessel began the search last July of the 24-kilometer-square target area covering 80% with SAR-generated, kilometer-wide swaths. Encountering typically bad weather with 40-knot gales and 4-meter seas, *Le Suroit* was reported to have made "some interesting sonar contacts," according to William Marquet, chief engineer on the ARGO project at Woods Hole.

The French sonar, according to its developers, has the highest resolution ever achieved for deep ocean research. Operating at depths to 6100 meters, the SAR reportedly can distinguish objects measuring as small as 30 by 76 centimeters.

The unit is towed at an altitude of 70 meters above the seabed, and its data are transmitted topside through a single coaxial cable over 8 kilometers long. The new sonar, a Thompson-CSF spokesperson said, has most recently been used for reconnaisance of manganese nodule deposits and various other military and deep sea research activities.

French Sonar Misses by Meters

Terry Snyder, the Klein field engineer aboard the *Knorr*, told *Sea Technology* that his look at the *Le Suroit* sonar records indicated she may have spotted some debris at the SAR's outer ranges but the French vessel's subsequent search pattern led away from the *Titanic* site. "The French made three or four contacts that deserved looking at. They don't appear to have located the *Titanic*, but they certainly did eliminate a lot of (search) area for us," he added. So far, no detailed analysis of the *Le Suroit* records has been started. But she did apparently pass within 275 meters of the *Titanic* during one of her search passes.


April maximum ice limit
April extreme iceberg limit
April 10, 1912: the Titanic steams out of Southampton. After brief stops for mail and passengers at Cherbourg, France, and Queenstown, Ireland, she begins her maiden voyage to America.
SOUTHAMPTON
41° 46' Lat.
50° 14' Long.
WOODS HOLE
NEW YORK
April 14, 1912: at 11:40 p.m., the great ship, steaming at 22½ knots (26 mph), strikes an iceberg. Three hours later, it sinks to the ocean floor.
R.V. SUROIT
R. V. KNORR
R.M.S. TITANIC

Unsinkable with three watertight compartments flooded, overconfidence led the *Titanic* to a collision with an iceberg and a 90-meter gash through five compartments. Research vessels *Le Suroit* and *Knorr* are dwarfed by the 270-meter, 46,328-ton luxury liner, now lying in nearly 4000 meters of water.

First indications that the *Knorr* had hit pay dirt, according to Snyder, were readings of debris via Klein's 100 kHz unit. A short time later, the video sightings confirmed the find.

Ballard said the wreck site was immediately bracketed with acoustic transponders, in actuality a 12-hour operation.

Two transponder nets had been laid previously and the *Knorr* was beginning to work out of range that early September morning. When the contact was verified, one net was pulled and then repositioned around the site. Then the ARGO was reflown at a higher altitude to lock the transponder positions—and the *Titanic's*—into the *Knorr's* computer.

The research vessel carried three Benthos Model 210 TR-17A transponders, three of the firm's new XT-6000s (with 25-centimeter glass housings), and three Sea Link Systems units.

Rounding out the waning hours of the expedition—and there were literally only a few hours left for collecting video and photographic records of the *Titanic*—Woods Hole's ANGUS (Acoustically Navigated Geological Underwater Survey) vehicle was lowered to fly "blind" over the wreck—guided by the transponder net and the *Knorr's* computers—for taking the 35-mm still photographs that have mesmerized the scientific community and the public alike.

The ARGO is part of a two-vehicle system under development at WHOI. Begun in 1982 and targeted for completion in 1988, the $2.8 million system is being funded by the Office of Naval Research. A smaller vehicle called *Jason* now is in the early stages of laboratory development and is expected to complement ARGO with the ability to perform close-up inspections and precision manipulator-arm sampling while the ARGO hovers overhead at about 30 meters.

Key components on the ARGO included the Klein side-scan sonar; video cameras, quartz iodide lights and the video telemetry system from Colmek Systems Engineering; an acoustic release, 35-mm cameras and strobe lights from Benthos; and the end-cable termination system from Preformed Marine (known now as PMI Industries).

Off-the-Shelf Components

None of the ARGO's components were specially designed, the company spokesmen revealed to *Sea Technology*. Virtually all were, for the most part, off-the-shelf instruments and systems that, at most, were slightly reconfigured to fit ARGO.

Klein Associates' Bill Key Jr., vice president for marketing, said his firm supplied a modular side-scan sonar, operating on the single 100 kHz frequency with a 1° beam pattern.

Tom Hilton, president of Colmek Systems Engineering, told *Sea Technology* that his firm's participation was extensive. In addition to the three Model 802 SIT (Silicon Intensified Target) video cameras, Colmek supplied a pair of Model 250 HPQ quartz iodide lights rated at 250 watts each. The firm's TVTM-6 video telemetry system comprised both ends of the link between ARGO and the *Knorr*.

Colmek was also responsible for all data and control transmissions between ARGO and the WHOI surface controller (an IBM PC computer).

Larry Gray, operations manager at Benthos, said his firm supplied off-the-shelf instruments and cameras

for both ARGO and ANGUS, as well as the transponders used for both long- and short-baseline navigation. On board the *Knorr*, he said, was a Benthos Model 455 navigation signal processor.

Gray told *Sea Technology* the ARGO was outfitted with two Model 372 camera systems (35-mm) and four Model 383 strobe systems rated at 200 watt-seconds each. Three more of the Benthos strobes—with remote heads—lit the scene for ANGUS' three Model 377 still cameras. The latter, operated simultaneously, used 16-mm wide-angle, 28-mm standard and 50-mm lenses.

The ANGUS vehicle also carried the firm's Model 865A acoustic release—used in this case only as a transponder—and a Model 2216 pinger for telemetry.

"Both of the towed vehicles also carried our 2110 altimeters," Gray added.

Completing the hookup and rounding out the list of major contributors was the ARGO vehicle end-cable termination system. Bob Eucher, president of PMI Industries, told *Sea Technology* that his firm provided the ARGO's electro-mechanical swivel (Model 711-20-2), the Farmor® cable termination and an "Everflex" bending strain relief.

What's Next for ARGO?

Following this second year of sea trials for ARGO, the vehicle will engage in its first scientific application this December. From Scripps Institution of Oceanography's *R/V Melville,* Ballard and his colleagues plan to survey a nearly 200-kilometer section of the East Pacific Rise, a submarine ridge between San Diego, California and Manzanillo, Mexico. The rise is part of the 64,000-kilometer ocean ridge system.

Since the first detailed exploration of the Mid-Atlantic Ridge in 1973, scientists have managed to accumulate only 192 kilometers of data in the past 12 years. On its first scheduled research task, Ballard and his geologists expect to cover almost 200 kilometers of the East Pacific Rise in only 20 days.

Based on this dramatic engineering test of ARGO, it appears that ocean science is on the brink of a new age of exploration and discovery. /st/

IMO Committee Recommends Two Emergency EPIRB Systems

In a recent development, the International Maritime Organization (IMO) Maritime Safety Committee has decided to recommend to its member administrations the use of 406 MHz as the frequency for emergency position indicating beacons (epirbs). The alternative was the L-band, as used by Inmarsat for its normal communications.

In a demonstration of fence straddling, the committee also recommended that as and when use of L-band frequencies for EPIRBS is demonstrated and proved, an L-band system should be accepted as an alternative to 406 MHz.

Arguments in favor of 406 MHz centered around the fact that Cospas-Sarsat system that uses that frequency is intended for use on land, in the air and on the sea while L-band is of limited use. L-band EPIRB operational demonstrations are now underway. It is possible that both systems will be able to operate compatibly.

Submarine Distress Beacon

Direct replacement for existing submarine distress beacons, provides substantially improved reliability and performance. Operating at precisely 3500 Hz, unit has an on-axis output source level of +183 dB to provide significantly extended detection ranges. Sonatech, Inc.

THE TAMPA TRIBUNE-TIMES, Sunday, June 29, 1986 9-A

WOODS HOLE, Mass. (AP) — Another summer expedition to probe the secrets of the Titanic's watery grave will go on as planned although an allied study by French scientists fell through, a spokeswoman for the U.S. team has reported.

"We did hear yesterday that they had canceled, but it doesn't affect our operation," said Shelley Lauzon on Friday at the Woods Hole Oceanographic Institution. "We would have had some technical collaboration with the French, but they had their own support vessels and their plans and we had ours."

The departure date of the institution's research ship Atlantis II with 19 scientists hasn't been set, but probably will be in the second week of July.

The big project this summer is testing of the "Jason" segment of the Argo-Jason underwater search sled at the grave of the English liner nearly two miles down in the North Atlantic.

The research crew, headed again by Robert D. Ballard, hopes to do its work without interruption after the flood of attention because of last year's discovery of the wreck site.

France's Institute for Maritime Research and Exploitation announced cancellation Friday of plans to film outside and inside the Titanic this summer.

The French group had planned tests of a robot undersea vessel designed to take film and still photos as far down as 19,600 feet below the surface.

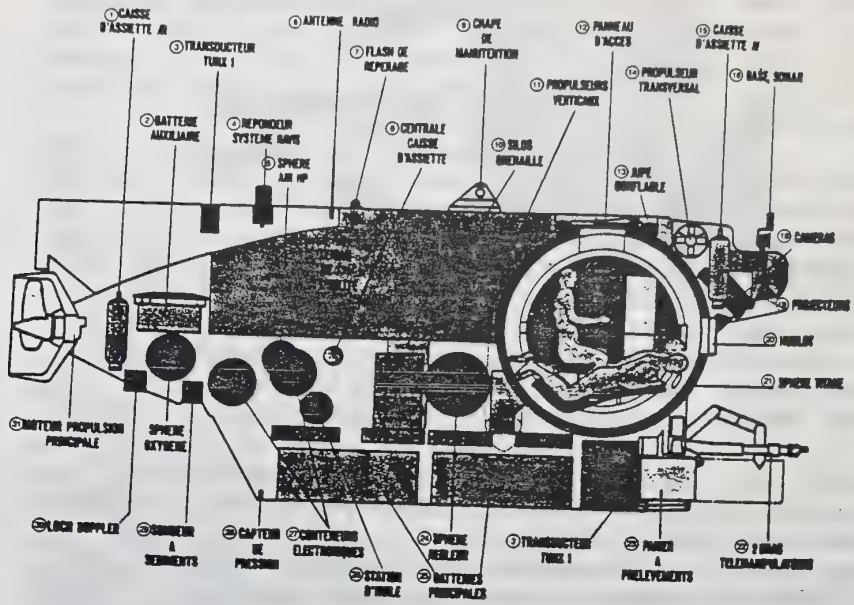
The Titanic sank April 14, 1912, on its maiden voyage to the United States after hitting an iceberg, killing more than 1,500 passengers and crew.

The French institute said the expedition with two vessels and diving units would cost about $2.1 million, but officials had been unable to find a sponsor to cover half the costs.

It was a joint French-American research venture aboard the Navy ship Knorr which discovered the Titanic Sept. 1, 1985, using the "Argo" part of the survey submersible to take pictures on the ocean floor.

The 12-foot Argo research vehicle is equipped with sonar, video gear and lights to skim along underwater sending reconnaissance back to the surface.

— 6000 m diving submersible



caractéristiques principales :
longueur totale 8.00 m
largeur 2,70 m
hauteur 3,45 m
masse 18,5 t
immersion 6 000 m
vitesse maximum 2,5 nds
durée mission
- normale 13 h
- survie 130 h
charge utile 200 kg

1. aft trim tank
2. auxiliary battery
3. transducer
4. "NAVIS" transponder
5. high pressure airtank
6. radio antenna
7. flash-light
8. trim control
9. hook-up part
10. ballast tanks
11. vertical thrusters
12. hatch
13. inflatable conning tower
14. lateral thruster
15. fore trim tank
16. sonar transducer
17. buoyancy material
18. cameras
19. lights
20. view port
21. titanium hull
22. 2 mechanical arms
23. sampling basket
24. variable ballast tank
25. main battery
26. hydraulic power unit
27. electronics housing
28. pressure sensor
29. sub-bottom profiler
30. doppler speedometer
31. main propeller

"SM 97" is a manned submersible designed and built jointly by CNEXO and DTCN for observation and work at depths up to 6 000 meters. It is the main component of an underwater system, which also includes all the equipment needed for the optimal utilization of the submersible.

The submersible is capable of exploring 97% of the total surface area of the ocean floor. Since its weight is outstandingly low (18.5 tons) in relation to its service depth, it can be supported by a vessel of relatively small displacement, and has a very good maneuverability.

Its low weight is achieved by the systematic use of new technologogy:
- titanium alloy for the pressure hull, the external structure, and the various containers,
- low-density syntactic foam for buoyancy,
- composite materials (fiberglass and carbon fibers)
- and by integration and miniaturization of electronic equipment.

The following features give the submersible its high capabilities:
- an hydrodynamic external shape, with low drag and improved maneuvering capabilities,
- new equipments for acoustic navigation, tracking, data acquisition and photography,
- a manipulation system, including two mechanical arms and a retractible sample basket,
- a high payload (200 kg) enabling the installation of extra equipment, the use of special tools, or improved sample capabilities,
- wide field of view, obtained by means of three portholes and six powerful lights making color identification easier,
- an acoustic transmission unit for sending TV pictures to the surface,
- redundancy of essential functions and jettisoning facilities (used if the submersible becomes entangled or stuck on the seabed or if it loses buoyancy accidentally, give it at last a high level of safety.

The operational use of a submersible involves necessarily the use of a number of associated systems to provide logistical support and to ensure diving safety and observation quality.
To achieve maximum efficiency, CNEXO has developed associated equipments adapted to the specific characteristics of the submersible. This integrated system includes:

• **on the support vessel:**
- surface navigation equipment, which allows to determine the exact position of the support vessel, through successive satellite readings ;
- data processing equipment, used to reduce the measurement and observation data obtained during dives. A fine analysis of the recorded data takes place on land at the end of the campaign;
- handling equipment used for launching and retrieving the submersible ;
- logistical equipment for submersible maintenance and reconditioning between dives ;
- a self-contained tool shuttle, used to carry tools for the submersible s manipulation equipment between the surface and the seabed .

• **on the submersible:**
- underwater navigation equipment for the direct interrogation of the acoustic transponders used to calculate the submersible s position, without the intervention of the support vessel;
- manipulation equipment, including two manipulator arms and a retractible sample basket. The gripping arm has five degrees of freedom, and the manipulation arm seven degrees of freedom;
- data acquisition equipment, including a set of sensors used to record altitude, pressure, temperature, heading, time and speed. The sensors are connected to a data acquisition unit which stores the data for subsequent analysis ;
- equipment for the acoustic transmission of TV pictures. This new system uses acoustic waves for image transmission .

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NAUTILE
Submersible — 6000 m
— 6000 m diving submersible

DEEP ROVER PERFORMS

Can-Dive Services Ltd. of North Vancouver, B.C. has just completed a series of record-breaking dives in Monterey Bay, California, with its deep diving, acrylic hulled submersible DEEP ROVER. Working under contract to the University of California at Santa Barbara, the DEEP ROVER was used to explore the biologically rich and geologically unique areas of the Monterey Canyon.

Following an intensive training program, the team of diving scientists, led by **Dr. Bruce Robison**, completed 51 dives over a 30-day period, routinely attaining depths of 2000 ft. (610M).

During the approximately 200 hours spent at depth, extensive use was made of manipulator and scientific collection systems to recover samples and data for further study on the surface. Experiments in bio-luminescence were recorded using an extremely low light video system.

The entire operation was recorded on video. A film company, Sea Studios, will be producing a B.B.C.-sponsored TV special for international release next year.

During the unprecedented 2-dive per day schedule, dive turn-arounds of 1 hour or less were often achieved to take advantage of weather windows. This dive series has clearly demonstrated the reliability and performance of the DEEP ROVER, and its suitability for intensive deep-water work.

The DEEP ROVER was built at Can-Dive's eastern Canadian facilities in joint venture with its designers at Deep Ocean Engineering. Following a 2-week period of operations off the coast of B.C. completing a film feature for Expo 86, the DEEP ROVER will return to California for a series of 3000 foot dives.

ALVIN GETS READY FOR SEA TRIALS

Months of hectic work redesigning ALVIN are almost over as the submersible is readied for sea trials in May. This major overhaul, aimed at improving the sub's reliability and scientific capabilities, has been accomplished in a short five-month period. Not only has the sub a new external look, but all of the electronics have been redone.

Just a few months ago, ALVIN could barely be recognized. The titanium sphere sat in one corner of the Iselin High Bay, the stripped frame nearby, and numerous white fiberglass sections strategically placed inside and outside the building created a maze for pedestrians. Slowly but surely the intricate mechanisms were reassembled and ALVIN took on its old form -- with some differences.

The old stern propeller and two lift props have been replaced by six small thrusters -- two located forward (port and starboard) and four on the stern. The thrusters utilize state-of-the-art direct-drive, brushless DC motors and will increase ALVIN's overall power efficiency and reliability. The old system, with brush-type electric motors driving hydraulic pumps with lines to hydraulic motors at each propeller, was not very reliable at deep depth. The oil-filled pressure compensated box suffered increased viscosity which caused excessive motor brush arcing beyond 3,000 meters and led to costly and time-consuming repairs.

Other changes to ALVIN include a smaller, lower-profile sail, new batteries with twice the power of the older models, a new hydraulic system, a new compensation system, and a complete rewiring and repanelling inside the sphere. New video monitors will give observers better viewing perspectives and pilots will now have a choice of switches, potentiometers, or joysticks with which to operate the sub (formerly only operated by switches).

Originally scheduled to leave Woods Hole in mid-April, ALVIN has been delayed four days due to unexpected difficulties encountered during installation of the new batteries. At the time the Newsletter went to press, ALVIN was scheduled to be at sea on Monday, April 28.

The changes to ALVIN were dictated by the costs of repair to the old propulsion system (installed over 20 years ago when ALVIN was first built and now out of date) and the need for greater safety. "As a pilot, I see these changes as major improvements," says Chief Pilot Ralph Hollis. "They should allow us to perform more science and give us a more reliable vehicle, with added power if needed."

Ralph and all the other pilots will be heading out with ALVIN on the first leg of the upcoming voyage to learn how to use the new propulsion system. "It's not vastly different from before," notes Ralph confidently. But because of the major overhaul, all of the pilots (who are also the ALVIN maintenance and operations crew) will have to be in attendance. This includes Senior Pilot Dudley Foster, Pilots Jim Hardiman, Don Collasius, Jim Aguiar, Will Sellers, Denzel Gleason, and newly Navy-certified pilots Paul Tibbetts and John Salzig. However, Paul and John won't earn their "Dolphins" (Navy insignia given to sub-qualified personnel) "until we hit Bermuda and the wetting-down party at the White Horse Tavern," says Ralph. Two other members of the ALVIN group, Kirk McGeorge and Mike Moran, are pilots-in-training.

Certification dives en route to and in the warmer waters near Bermuda will test all of the new electronics. The second leg, Bermuda to Bermuda, will continue ALVIN engineering tests. Dives are scheduled for the Bermuda Biological Station and Japanese television. In addition, the Sea Beam system recently installed on ATLANTIS II will be tested and calibrated.

Titanic tours planned

NEW ORLEANS — An expedition forming here plans to take passengers on dives deep under the surface of the Atlantic Ocean to inspect the sunken Titanic. The trip is a project of the Louisiana Science Centre, which will study what happened to the mammoth vessel and convert the knowledge into a traveling exhibition and TV documentary.

Houston Chronicle News Services

2/24/81

Robert D. Ballard—Sitting on Top of, And Under, the World

By Larry L. Booda
Editor Emeritus

If there were the underwater equivalent of a human riding a skyrocket, it would be Dr. Robert D. Ballard. In a short 15 years he has become the leading pioneering explorer of the underseas portions of the earth's crust.

In his specialties—geology and geophysics—alone he would stand out. But in one of the curious twists of scientific endeavor he made a major biological discovery. In his initial exploration of "hot spots" and fractures in the ocean bottom crusts near the Galapagos Islands in the submersible *Alvin,* he not only discovered the seafloor spreading where vents emit minerals, hot water and magma, but found forms of life in the stygian blackness of the bottom at depths of 3,000 meters.

Those life forms, giant tube worms, huge mussels and a variety of plants, exist by chemosynthesis without light, as compared with all of the plants at the surface which are dependent on sunlight for photosynthesis. He thereby alerted the marine biology community to whole new field to study. Subsequently it has been discovered that in sea bottom areas remote from the Galapagos the life forms around the hot vents are the same or closely similar, raising the question of how they are transported in bottom water ranging from 3°C to 6°C.

So, can we call Ballard a geological biologist, or a biological geologist? His explorations along the mid-Atlantic Ridge and other seafloor spreading areas in the Pacific, often working closely with French scientists, have revealed how polymetallic sulphides are transported from inside the earth and deposited on the ocean floor and in solution into the water column.

But the restless, hard driving Ballard is not satisfied to keep on a narrow scientific path. As a scientist who is one of the biggest users of manned submersibles, he has spread his activities into undersea archeology, the best known being the discovery and photographing of the sunken ocean liner *Titanic* off Newfoundland last summer. That expedition created some tension with the French, whose ship had mapped 75% of the wreck area before Ballard's arrival on the scene to search the remaining 25%. Hopefully, relations with the French will improve this coming summer when another joint expetition to the *Titanic* site is planned. (News on the new expedition can be found in *Sea Technology* for January, page 60.)

Ballard is a qualified scuba diver, and is a member of the Boston Sea Rovers, a small but widely influential diving club. He is uniformly pleasant, often bubbling with enthusiasm and will talk for hours about his projects. He handles himself superbly in front of a crowded press conference, such as the one at the National Geographic Society last September to reveal the first results of the *Titanic* expedition.

Ballard is a product of the U.S. midwest, born in Wichita, Kansas June 30, 1942. He earned his B.S. degree in chemistry and geology at the University of California, Santa Barbara, in 1965. Subsequently he took graduate work in oceanography at the University of Hawaii in 1965 and 1966, and University of Southern California in 1966 and 1967. He gained his Ph.D. in marine geology and geophysics at the University of Rhode Island in 1974.

Ballard served as an officer in both the Army and the Navy. Now an east coast resident of Cape Cod, he is now a senior scientist and head of the Deep Submergence Laboratory of the Woods Hole Oceanographic Institution.

Ballard's affiliation with two military services is explained by the fact that he was in the Reserve Officers Training Corps while at the University of California, with a specialty in intelligence. He was commissioned as a second lieutenant from 1965 to 1967. When the Vietnam war came he transferred to the Navy.

After joining the Navy in 1967, he soon found himself ordered to the Office of Naval Research branch in Boston. This duty developed in many visits to the Woods Hole Oceanographic Institution (WHOI). Having worked earlier with the Ocean Technology Section of North American Aviation where the *Beaver MK IV* was built, he soon became interested in the WHOI's *Alvin*. That was the beginning of his climb to fame. /st/

Explorers view interior of Titanic

Associated Press

WOODS HOLE, Mass. — Deep-sea explorers got their first, thrilling view of the sumptuous interior of the sunken Titanic yesterday, using a lawnmower-size robot to photograph the luxury liner's grand staircase and a chandelier hanging from a ceiling.

"It was like landing on the moon," the excited expedition leader, Robert Ballard, said in a ship-to-shore conversation.

"We went down about four decks into the ship and went into one of the rooms off the staircase and went right up and looked at a beautiful chandelier hanging on the ceiling," said Ballard, describing how he and two other scientists moved the video robot by remote control from their tiny submarine, which remained outside the wreck.

Ballard told colleagues at the Woods Hole Oceanographic Institution that at one point he and his fellow passengers maneuvered the sub above the sunken hulk.

"We got beautiful, spectacular down-looking pictures of the ship and then went and spun on the bow," he said.

"Going down the staircase, sitting on the deck of the ship at 12,500 feet and going inside four decks and going into a room and looking at a chandelier is amazing."

The researchers were able to peer inside the Titanic's remains using the video robot Jason Jr., which is attached to the submarine Alvin by a cable. Jason Jr. contains video and still cameras.

In a ship-to-shore interview last night, Ballard said viewing the Titanic from the inside "was like going back in time."

Ballard said the crew planned to go down to the wheelhouse area today and send Jason Jr. into the first-class staterooms.

Attempts fail to open safe of sunken liner

From News Services

WOODS HOLE, Mass. — The first videotapes from inside the Titanic showed yesterday a coral-covered chandelier swinging eerily in the ocean current and other well-preserved artifacts of the fabled wreck.

Meanwhile, searchers in the submersible craft Alvin said they found the Titanic's safe yesterday and tried unsuccessfully to pull it open with a remote-controlled claw.

The safe's handle was grasped, but it would not open, the leader of the expedition, Dr. Robert D. Ballard, reported by radio. He and his companions uncovered the safe in their first close-up survey of the debris to the stern of the vessel — "a tremendous twisted pile of wreckage," he said, the size of a city block.

The vivid color videotape images showed with remarkable clarity the coral that had begun to grow from the ceilings of staterooms in the so-called "unsinkable" luxury liner that went down in the North Atlantic on her maiden voyage 74 years ago.

The videotapes, shot by the remote-controlled robot called Jason Jr., were flown to Woods Hole Oceanographic Institution to give the world its first glimpse of the ship's interior since the Titanic struck an iceberg and sank on April 14, 1912, with a loss of 1,513 lives. There were 704 survivors.

Officials at Woods Hole also showed reporters photographs taken by the researchers, including one looking down the opening of the ship's grand staircase.

Other photographs, which like the videotape were remarkably clear, showed the hull of the Titanic buried in sand with a lone porthole above the seabed; a shot of where the stern was ripped from the front of the ship, and an anchor and chain that appeared to be hanging from the side of the ship.

The researchers said they had seen enough of the sunken luxury liner to conclude they would find no remains of the victims.

"It's almost like going to a museum. If we were ever going to see any human remains, we would have seen them," said Ballard, who discovered the Titanic's grave last September as head of a U.S.-French team. He added that he was relieved there were no remains.

Radiating from the wreckage, Ballard said, was "a tremendous series of artifacts" — a shoe, champagne bottles with corks intact and a great diversity of other items, from chamber pots to stained glass windows.

As seen though Alvin's porthole, the ship's safe had a dial and "a beautiful crest." Its contents remain, for now, a mystery.

The giant ocean liner carried hundreds of wealthy and prominent passengers who may have stored jewelry and other valuables in the ship's safe. The safe may also have held currency for use by the ship's bursar.

In its deeper and deeper penetration of the ship, Alvin and its robot scout have used television and still cameras to explore, first, the relatively intact forward part of the vessel.

There is a morbid fascination with the aft steerage section where many of the victims huddled as the Titanic went down and where any possible human remains would be found — although Ballard insists organic remains would have long since been scavenged by sea creatures.

Many hours' worth of tapes were made. Included in the three minutes of video that was released were scenes showing the mini-submarine carrying the scientists sitting on the bow of the Titanic, exterior shots of the liner and some of the debris, officials said.

Today, the explorers planned to use Jason Jr. — manipulated from the mini-sub on a 200-foot tether — in its fifth mission almost 2½ miles beneath the surface to probe the 882-foot ship's bow.

By July 24 — before the start of hurricane season — researchers will wrap up the venture and make the four-day return trip to Woods Hole. A news conference was planned July 28 at the National Geographic headquarters in Washington, D.C., to release the rest of the still photos and videotapes.

Robot in Titanic tangle

WOODS HOLE, Mass. — An underwater robot peered through portholes of the sunken Titanic yesterday but got tangled in its own line and spent most of the day on the outside of the 74-year-old wreck.

The pictures taken by the robot, Jason Jr., showed that the ship's brass mast light is still intact, but that letters spelling out "Titanic" have apparently faded.

Ballard and a crew of 55 scientists and sailors arrived at the site 450 miles southwest of Newfoundland a week ago. Yesterday was the fourth in 12 scheduled days of diving.

Seventh dive to Titanic postponed

From News Services

WOODS HOLE, Mass. — The Titanic expedition yesterday postponed a planned seventh dive to the sunken luxury liner, citing fatigue among crew members who have made six dives in as many days.

"They're resting, charging the batteries (of the submarine Alvin), and checking things over," said Shelley Lauzon, a spokeswoman for the Woods Hole Oceanographic Institute.

The crew had been set to take overhead photographs of the main part of the wreck yesterday after sending back dramatic pictures Friday of a cave-like interior filled with icicles of rust.

Lauzon said there were no technical problems with either Alvin or Jason Jr.,

Titanic said sunk by leak

From News Services

WASHINGTON — Explorer Robert Ballard yesterday unveiled a photographic treasure obtained on his second — and avowedly final — visit to the Titanic, including evidence certain to revise some historical accounts of how the great liner went down.

Ballard, who discovered the sunken luxury ship in the North Atlantic on Sept. 1 last year, said its collision with an iceberg in April 1912 did not create a huge gash in the hull — as many, including himself, had long supposed. Instead, he said, the inch-thick plates on the hull simply buckled enough to create a fatal leak.

The undersea explorer said the damage occurred where historians had thought it did, but — contrary to theory — there was no gash.

Ballard told reporters the comprehensive photographic exploration of the wreck in 12 dives earlier this month showed "absolutely no evidence of any gash. It appears the damage was (the) separating of the riveted plates."

The 882-foot, 46,000-ton Titanic, billed at the time as "unsinkable," struck an iceberg on its maiden voyage and sank April 15, 1912, killing 1,513 of the 2,224 people aboard.

It has long been thought the iceberg gouged a 300-foot long gash on the starboard side, ripping open five of the Titanic's compartments and letting them flood.

The Titanic's unsinkable reputation was built on the idea that four of its 16 compartments could be flooded and the ship could stay afloat. If a fifth one flooded, the combined weight of the sea water would pull the ship too low in the water.

Ballard said the iceberg apparently caused the steel plates — which tapered in thickness from about nine-sixteenths of an inch at the bow to about one inch at midsection — to buckle or otherwise damage the riveting. The damage was on the starboard side of the bow back about a third of the length of the ship.

Many of the buckled plates can be seen clearly in the more than 50 hours of videotape and 57,000 still photos shot by the Woods Hole Oceanographic Institution crew headed by Ballard.

Ballard said also that the fact the stern of the liner was found 600 meters from the bow section shows that the ship broke apart — not when it hit bottom, 12,500 feet from the surface, but on the way down. He theorized the ship might have imploded from the pressure.

On the other hand, he said, the bow section was much more intact, though all four funnels have disappeared — perhaps disintegrated — and "the entire wheelhouse has been eaten" by wood-boring organisms.

Ballard said he was not surprised, after noting "the absence of any wood, anything organic," that he found no evidence of human remains. The only organic artifact found was a patent leather shoe, he said.

Ballard said he spotted one safe. Photos taken by a sled named Angus and a robotic video scout called Jason Jr., showed at least four others.

But he said that anyone who tries to salvage such artifacts isn't likely to get his money's worth. Most retrievable objects — those lying directly on the ocean floor — are from the steerage area of the luxury ship, he said. There is no way, contrary to published fictional suggestions, to raise the broken ship itself, he added.

Rust was everywhere on the wreckage, except for copper and ceramic objects. The photos showed gleaming copper pots and pans from the ship's kitchen, the head of a doll, a copper cup sitting upright atop one of the engine boilers.

Exploration of Titanic ends

Associated Press

WOODS HOLE, Mass. — Scientists, technicians and Navy officers completed their 12-day exploration of the Titanic and were sailing for home yesterday with more photos and videotape of the shipwreck.

The deep-sea research team from the Woods Hole Oceanographic Institution and from the Navy was expected to arrive in this Cape Cod port Monday at 10 a.m., said spokeswoman Anne I. Rabushka.

Researchers left the site 450 miles southeast of Newfoundland on Thursday after completing the 11th and final dive in the three-man submarine Alvin.

Chief scientist Robert Ballard, who relayed details of each day's dive to reporters via ship-to-shore telephone conversations with Woods Hole officials, will not talk to reporters until he arrives in port, Rabushka said.

In a conversation with Woods Hole officials Thursday night, Ballard said the last dive was the best and most dangerous as the team sent the camera-equipped, tethered robot Jason Jr. inside the promenade deck.

No other explorations are planned at the site where 1,513 people were killed when the Titanic struck an iceberg April 14, 1912, on its maiden voyage from England to New York.

MICOPERI SUBMARINES: CLOSED CIRCUIT DIESEL POWERED FOR COMMERCIAL, SCIENTIFIC AND MILITARY PURPOSES

by **Captain Alfred S. McLaren,** USN (Ret.), Arctic Analysts Inc., Boulder, Colorado

During the early 1970s, MICOPERI S.p.A. of Milan, a company founded and made up of former Italian naval officers, mainly submariners and combat divers, and of experienced naval architects and engineers, began a series of design and engineering studies of long range submarines to be propelled by non-conventional means (as opposed to battery-electric or nuclear power). Construction subsequently began in 1977 on their first submarine testbed/prototype, the PHX-01, and simultaneously a closed circuit diesel engine using pressurized oxygen to power it. The tests and seatrials with this combined system were successful, and in 1979, led to the construction of a second more advanced and larger submarine, the 80 ton "IMI-35" (Figure 1).

It had a similar power plant of greater capacity, capable of offshore and deep ocean operations to depths of 350 meters for at least 24 hours. Sea trials were successfully completed during 1982/1983 and the MICOPERI submarine "IMI-35," a multipurpose submarine equipped with thrusters and manipulators, is now, with the aid of a support ship, fully capable of executing a wide variety of underwater tasks. Surveys, diving lock-out operations, transfer of personnel to/from underwater habitats, offshore oil rig underwater inspections/servicing and submarine rescue operations are some of these. It is currently engaged in at sea operations as a testbed in support of the development of advanced miniaturized components for MICOPERI closed circuit diesel power plants.

Experienced submariners like myself who have inspected and gone to sea on the "IMI-35" have been immediately impressed by the knowledge and professionalism of the people involved. Equally impressive is the great potential of such systems for not only extended inshore and open ocean commercial and scientific work, but also for deep ocean marine search and salvage and/or archaeology, and for submerged operations in ice-covered waters. Hitherto, only nuclear powered submarines could safely operate fully submerged for extended periods. Additionally, power plants such as the closed circuit diesel generator should be of considerable value as high capacity independent energy sources for various offshore and deep sea applications as habitats for divers and scientists, to name one of a myriad potential uses of this sort. It is no wonder that MICOPERI S.p.A. has had many requests for visits and demonstrations, or that the Italian and other navies have expressed considerable interest in the technology that MICOPERI has developed and tested for well over 1200 operating hours, 700 of which have been at sea.

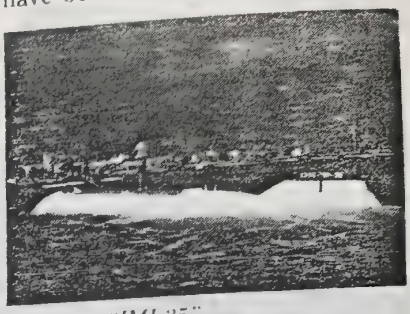


Figure 1: "IMI-35"

MICOPERI's *third* submarine to embark on sea trials (scheduled for early 1986) with a closed circuit diesel power plant will be their Albacore hull shaped "EEC-22" (Figure 2). This 25 ton submarine will be capable of carrying and supporting four fully equipped divers or several oceanographers with a ton of scientific data collection and recording equipment at speeds up to 8 knots for periods up to twelve hours fully submerged beneath the sea. It will also be fully capable of serving as a

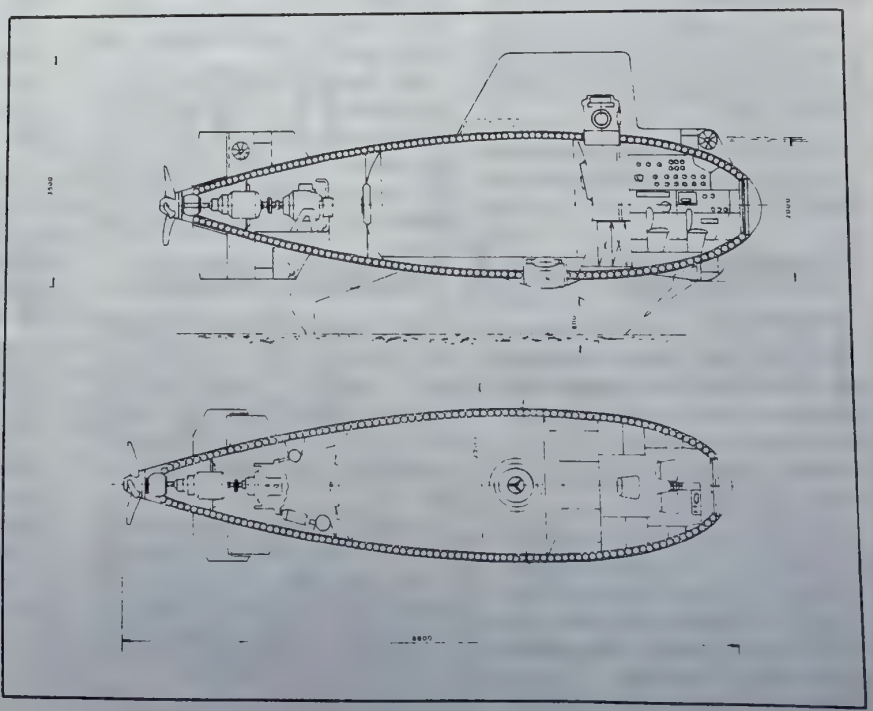


Figure 2: "EEC-22"

D.S.R.V. (Deep Submergence Rescue Vessel), capable of rescuing as many as 18 crew members from a disabled submarine resting on the ocean floor at depths down to 650 meters.

Larger submarines of 100, 200 and greater tonnage and capabilities have already been designed and their construction only awaits signed contracts from potential customers. One of approximately 130 tons, the "Class 100" for example, will have as its main power plant a closed circuit diesel engine and as its auxiliary power plant, a closed circuit diesel generator, an electric motor and a propulsion battery. It will be capable of carrying payloads of up to three tons at speeds of 16 knots for 590 nautical miles (36.8 hours), 12 knots for 913 nautical miles (76 hours) or at slow speed for almost 15 days, fully submerged and divorced from the outside atmosphere. Through the addition of "side pocket tanks" during construction, it can even be configured to carry a cargo of petroleum (Figure 3) at depths down to 150 meters. This would be an ideal vehicle to demonstrate that oil could be safely transported from Panarctic Oils Ltd.'s "Bent Horn" site in the Canadian Arctic Islands to Resolute Bay along the Northwest Passage!

Figure 3: "Class 100" Submarine

Unique to all MICOPERI submarines, besides the closed circuit diesel engines, is a design concept which should put MICOPERI's President, **Dr. Giovanni Makaus**, its Chief Naval Architect, **Dr. Giunio Santi** and its superb staff of design and test engineers in the forefront of western world submarine technology and designers. This is the new toroidal pressure hull (Figure 4) which will appear with the submarine "EEC-22" and will be capable of storing oxygen for its closed circuit diesel engine at pressures up to 3000 psi within its tubes. Norske Veritas incidentally, has already approved the design and construction drawings of the "EEC-22" and will witness the strain gage tests during the initial sea trials.

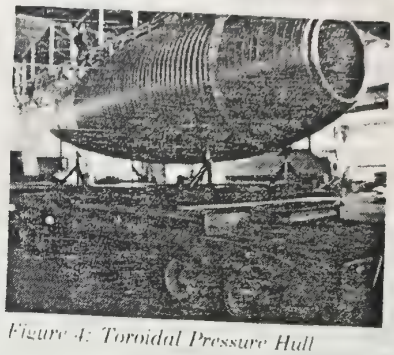


Figure 4: Toroidal Pressure Hull

Although the advantages of saved space within and without the pressure hull are immediately obvious (e.g., no high pressure oxygen storage bottles are required), not so obvious and yet infinitely more important operationally, is the fact that comprehensive computer math model studies by MICOPERI indicate that a larger, "fleet size" or 2000 ton submarine with such a pressure hull and closed circuit diesel propulsion engines and electric generators of the requisite horsepower/kilowatts would be capable of traveling some 127,000 nautical miles or 126 days at 9 knots. Alternately, it would be fully capable of traveling some 4600 nautical miles at 23 knots (or 8.3 days). Such a submarine would be more than capable of scientific work for extended periods in the open ocean or the polar regions, and of transporting such Arctic resources as petroleum from potential production sites in the Canadian Arctic Islands, Scoresbysund in eastern Greenland, or offshore sites in the Beaufort Sea, to southerly refineries and markets. In conclusion, it would seem that a non-nuclear alternative to long-range/endurance submarines is now at hand!

Worldwide Ship Navigation Via Laser Disc Electronic Chart

The world's first marine data chart system has been developed in Sweden, according to a research and development firm there, which "can store thousands of charts on five optical laser discs and provide a completely automatic chart update display between any two world ports."

The system is based on an invention by scientists at Lund University. Called the Disc Navigation System it has proved successful in pre-operational tests conducted in the North Sea, according to Disc Navigation AB (Sjobo, Sweden), a joint venture of Norwegian shipowners Wilh. Wilhelmsen, Nautisk Forlag and the Swedish firm Lidaris AB.

Full-scale testing aboard the Wilhelmsen container ship *M/S Rosa Tucano* will precede market introduction later this year, according to a Disc Navigation spokesman.

To present chart data, the system uses a 19-inch, high-resolution video screen capable of displaying 1° by 1° extracts of any chart, plus pictorial information utilizing 250 shades of colors. The chart is built up around the ship's position, which is tracked across the display in true motion. If the course has been pre-programmed, the correct course and waypoints are also shown. It is also possible to zoom in on narrow passages and navigational marks, such as lighthouses and other vessels, for detailed study.

Nautical charts for the whole world are available in digital form on the system's 650 Megabyte laser discs. These contain the entire range of information covered by the thousands of conventional charts and various pilot books that a modern ocean-going vessel is normally obliged to carry and continuously update on-board—a laborious and extremely time-consuming procedure.

Radar data are displayed simultaneously with the relevant chart presentation. Discrepancies are indicated in color on the screen, as are other vessels in the vicinity, which are also tracked in true motion on the chart. The correct course, speed, bearing, critical time and closest point of approach for targets can also be presented. Positional data are integrated continuously in the presentation, along with readouts of latitude, longitude, speed and heading. Fairway depths can be corrected for tides, and recurrent maneuvers can be preprogrammed for control by autopilot. The presentation can also be simplified by eliminating extraneous chart information, such as soundings in excess of draft requirements and lighthouse data during daytime.

The digital information for updating or complementing the electronic chart is stored in a magnetic memory and sent to the ship where it is fed into the onboard computer. It can also be transmitted to the vessel via satellite. The disc navigation system also features a "black box," an electronic log book for storing a complete record of events automatically

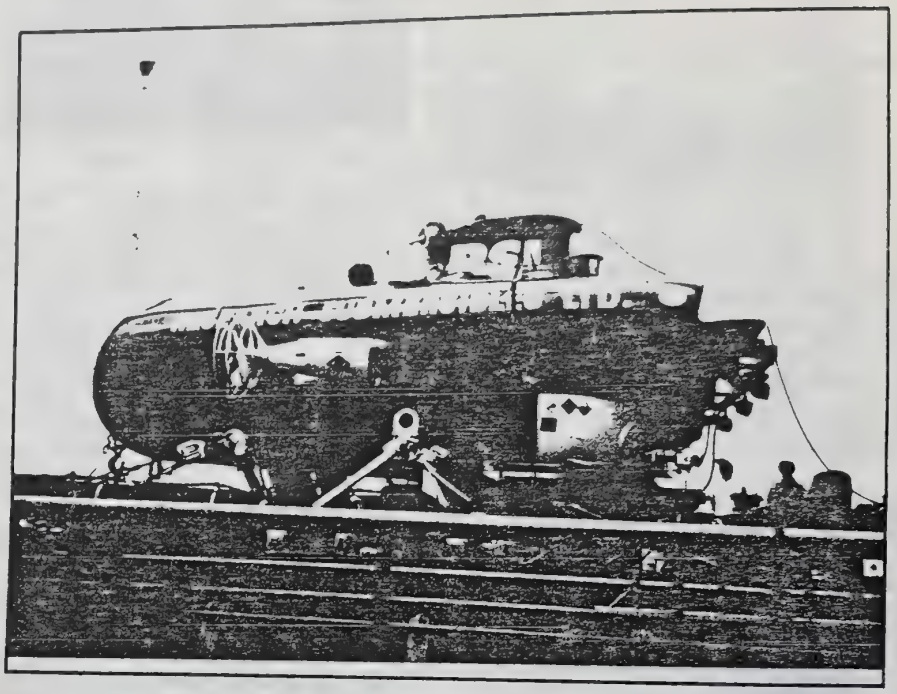
Manned Submersibles: Valuable Applications

Expansion in the Manned Submersible Industry Leads to Important Accomplishments.

M. Christine RoseSmyth
Marine Ecologist
Research Submersibles Ltd.

Since the December 1984 "submersibles" issue of *Sea Technology* to the present, four of Research Submersibles Ltd.'s vessels, in five locations have completed 983 dives in scientific research, tourism/education, and commercial fields.

Among the accomplishments of this small company in the manned submersible business are: 1887 first time submersible divers, 983 submersible dives, nine scientific projects, 10 photojournalism projects, two TV documentaries, one TV commercial and one historic commemoration.



Aboard the Japanese support ship *Shoemaru*, RSL's *P2* submersible is being readied for diving on the wreck of the 70,000-ton World War II battleship *Yamato* last August. Considered the largest battleship ever built, she was sunk on a suicide mission off Okinawa during the closing days of the war. (Photo by Charles Sillett.)

Varied Operations

In that December 1984 issue, Research Submersibles Ltd.'s plans to revitalize exploration submarines previously used in the North Sea and offer them at competitive rates to the research community was described and the operations at the University of the West Indies, Discovery Bay Marine Laboratory detailed.

Science continues to be a major market for RSL, with the development of research programs in Jamaica, the Turks and Caicos Islands and on Grand Cayman, and the lease of the 2,000-meter-rated *P5* to the Hawaii Underwater Research Laboratory. New developments have been the establishment of tourism/educational operations in Jamaica and Grand Cayman, and RSL's entry into commercial markets with the successful bid to provide a submersible for Japan's Tombstone of the Sea Committee salvage of the battleship *Yamato*.

Important Findings

Undoubtedly, the highlight of the year was the participation in the Tombstone of the Sea remembrance ceremonies for the crew of the *Yamato*. This project, to identify the wreck of the largest battleship ever built which sank with the loss of 3,000 of her crew on a suicide mission to Okinawa in the latter days of World War II, had developed over the years into an operation of special significance to the Japanese people. With the advent of the fortieth anniversary of the sinking, the goal of laying to rest the souls of the lost crew gained further importance.

Previous photographic surveys of the site of the sinking of the *Yamato* indicated that a massive wreck did indeed lie on the sea floor at 320 meters. It was up to RSL in association with Fukada Salvage to make a positive identification of the wreck and to recover artifacts and, if possi-

ble, human remains.

The recently refitted and re-classed Hyco-built *P2* was transported to Tokyo by Japan Airlines for the operation in the South China Sea in August. *P2* was fitted with a UMEL still camera and an Osprey OE 1335 underwater color television camera to provide broadcast material for NHK TV, and its original Hyco manipulators. Members of the Tombstone of the Sea Committee including author of the award-winning book *Otokotachi No Yamato*, Jun Hemni, and *Yamato* survivor Mitsugu Uchida, and reporters and cameramen of the Japanese media accompanied RSL pilot John Jury on the dives. The identity of the wreck was confirmed by the location of the *Yamato's* unique bulbous bow and the Imperial crysanthemum, a 1.5-meter diameter wooden crest which replaced the name plate on the prow of the ship. The *Yamato* was 263 meters long and weighed over 70,000 tons. Her armament included a main battery of nine 18-inch guns, fire power which is still unmatched today. The discovery of the wholly intact emblem and 18-inch shells on the second dive of the operation left no doubt that this was indeed the *Yamato*. While commemorative services were held aboard one of the support ships by families of the crew and survivors, a floral tribute was placed on the wreck itself by Hemni and Uchida.

Other dives located the upturned stern of the wreck with three of the massive propellers still in position, the stern gun turret, the forward turret with gun barrels intact, and sections of the bridge. Although the stern and bow of the ship were relatively undamaged, the mid-sections of the vessel were a tangled mass of metal, confirming the observations that the ship exploded as she sank.

The losses of the *Yamato* and *Titantic* rank as two of the greatest maritime disasters the world has known. It is an interesting coincidence that both ships have been conclusively located in the same season.

Commercial Adaptations

The use of submersibles in the educational tourism market has been pioneered by RSL in the Cayman, Turks and Caicos Islands in the Caribbean with notable success. *PC8*, *PC1802*, and *PC1203* are currently diving daily. The shore based operation which was developed at the Discovery Bay Marine Laboratory adapts easily to accommodate multiple short dives in the day. Customers meet at the shore-side office for a video presentation, and are then ferried to the dive site. The submersible is towed to the site each morning and remains on location throughout the day. Communications with the support boat and the shore base are in effect at all times.

The pre-planned dives are centered around a known, mapped location but the actual route may vary from dive to dive. Each dive covers the full range of biological and geological zones within the capability of the submersible's depth range, and the pilots are qualified marine biologists or have a special interest in marine life. The opportunity to make new scientific observations is ever present and adds an extra dimension to the dives. For example, a school of five hammerhead sharks were spotted at 183 meters recently. Observations which complement the research efforts of our professional scientific customers are recorded and passed on, and our own biologists are in the unique position of being able to continue their studies wherever RSL is located.

Benefits and Possibilities

Divers and non-divers alike are excited by the opportunity to extend their view and knowledge of the greatest area of our planet Earth. For divers the attraction is the chance to forget the depth gauge and decompression schedule and enjoy a deep dive with no need to consider the time. "The Wall", typical of so many Caribbean reefs, is now totally attainable. Introducing non-divers to the underwater world is especially rewarding for they see far more than they ever believed would be possible. Photography through the large front viewports is also enthusiastically pursued.

Examining Historical Findings

The "living fossils" of the deep wall and island slope, 107 meters and deeper, and the huge geological formations below 198 meters attract the greatest interest. RSL's biologists, alone or in association with others have been studying two of these animals, the slit-shell, *Entemnotrochus adansoniana*, and the stalked-crinoid, *Cenocrinus asterius*, in the three Caribbean locations of Jamaica, Grand Cayman, and Turks & Caicos. Data from these studies are generating new perspectives on deep sea organisms. The paradigm of evolutionarily ancient species as rare, barely surviving organisms is being replaced by one of healthy, successful, competing animals.

Massive blocks of rock, out-cropping from the slope or slumped from higher up are a constant feature on the Island Slopes of all three Caribbean islands that we have dived to date. The most spectacular of these, a cluster of boulders and pinnacles up to 30 meters high are now a regular dive site for our Cayman tourism operation. The rocks support ahermatypic stony corals, gorgonians and antipatharians which in turn support stalked and unstalked crinoids, brittle stars, basket stars, arrow crabs, and hermit crabs. A similar site was dived intensively by a group of 28 petroleum geologists representing all the major North American companies at Discovery Bay, Jamaica in March.

The novelty of high technology submersibles available to the public has generated much interest among the media especially the sports-diving media, and RSL has participated in several photojournalism projects. For the diving community the emphasis has been on producing high quality photographic materials on the deep reefs. Another project features *PC8* assisting a hunt for wrecks at East End, Grand Cayman. *PC8* was again the centre of a commercial to demonstrate the ruggedness of Casio dive-watches. The watches were taken to their depth limit of 200 meters on the exterior of the submersible and filmed from the interior. They performed perfectly throughout the dives.

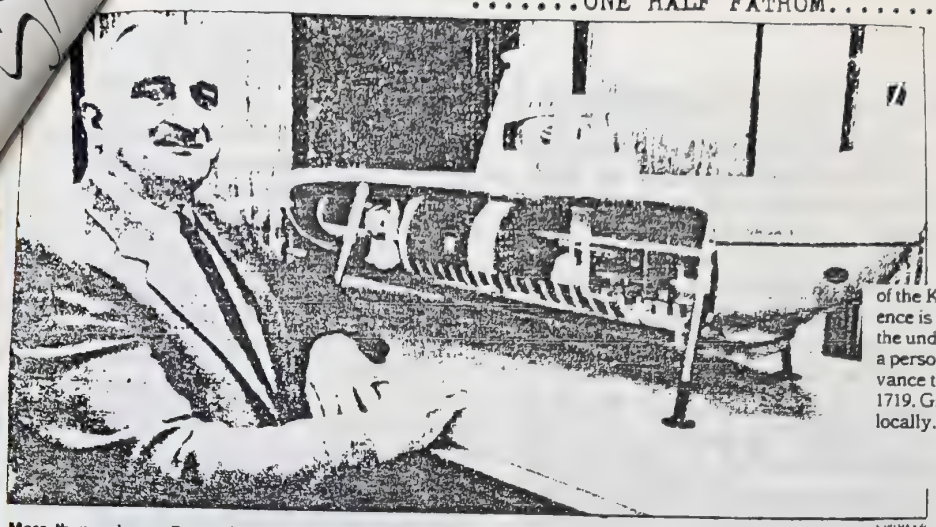
The renewed acceptance of manned submersibles in the marine industry and the expansion of these vessels into new markets is rapidly gaining momentum. We are confident the next year will feature increased manned submersible activity in all the areas covered in this article and more.

M Christine RoseSmyth is corporate secretary/treasurer of Research Submersibles Ltd, Grand Cayman. She is a 1978 graduate of Trinity College, Dublin, and is currently completing a Ph.D. at the Department of Zoology, University of the West Indies, Jamaica. Coordinator for RSL's research activities, RoseSmyth also pursues her own interest in deep water malacology through the company.

Atlantis
SUBMARINE

Discover a new world aboard Atlantis' Submarine

A genuine adventure awaits those who board the ATLANTIS, the world's first professional recreational submarine, moored in George Town Harbour, Grand Cayman, British West Indies. Here, dynamic coral formations, a kaleidoscope of tropical fish and famous ship wrecks are the stuff of spectacular underwater experiences. For the first time, visitors of all ages can explore the thrill of an underwater world in complete comfort. Viewing from large windows in the hull, passengers can see the fantastic coral formations and schools of tropical fish. Here, they can also observe the delicate beauty of the sea fans and sponges, while the submarine maneuvers over the reefs. Part of the Cayman Islands' appeal is the diversity of its underwater life. Here, the reefs teem with a profusion of tropical fishes, like the Butterflies, Angels, Parrots and Damselfishes. The sandy reef fishes



More than a dream: Retired Canadian Navy submariner Allan Kastner wants to go down to the sea again, this time in a privately-owned nuclear powered submarine designed for peaceful purposes, pictured here in model form. Kastner's Ottawa company is designing and building the nuclear reactor for the Saga N, which he says will sail in 1988

TORONTO STAR MAY 31/85

Ottawa man busy signing up clients for his private nuclear submarine

By Pat Brennan Toronto Star

"The air-water interface can be a terrible place, but inner space is always tranquil," says Allan Kastner.

Translation: The North Atlantic can get pretty darn miserable, but down below all is smooth.

Your average submarine sailor doesn't talk like that, but then again Kastner isn't your average submariner.

When he retired from sailing submarines for the Canadian Navy, he started designing his own nuclear powered submarine — the first one with a peaceful purpose.

And it has become more than an old salt's dream. Kastner says the sub will sail in 1988 and claims he already has clients signed up to charter it at $35,000 a day for ocean-floor explorations and research.

Kastner is executive vice-president of Energy Conversion Systems of Ottawa, which is designing and building the nuclear reactor to power the 100-foot-long submarine currently being built in France.

A consortium of Canadian companies, including ECS, have formed a partnership with a marine research department of the French government and some private French companies to create International Submarine Transportation Systems Inc. of Halifax.

That firm will own the $75 million submarine and its $55 million operations base at an undisclosed port on Canada's east coast.

Sea trials

The submarine will sail its first year with a conventional engine for sea trials and then be lenghed to 130 feet to accomodate the reactor.

Kastner said his submarine could operate underwater for as long as the crew desired, whereas conventional submarines can stay under water a maximum four days and battery-powered minisubs now used for ocean floor research and exploration can stay down only a matter of hours.

His sub, eventually to be named Saga N, will have a nuclear engine about one-twentieth the size and power of the reactor on a modern U.S. navy sub.

The Saga's pressure hull was built in the late 1960s for French marine explorer Jacques Cousteau, who wanted a larger submarine for his underwater filmmaking and research. But the conventional engines were unsatisfactory and the sub was never finished.

It has been sitting in a French warehouse since then and Kastner says it's in showroom condition.

The Saga will have an operating depth of 1,968 feet (600 metres) and a crushing depth of 3,836 feet (1,200 metres), which means if it goes beyond that depth it will succumb to pressure.

She will carry a crew of six and up to seven divers who will use it as a support ship to supply oxygen and heat as they work on the ocean floor to a maximum depth of 450 feet.

On site

"The divers can spend a lot more time doing the productive work on the bottom no matter what the weather is on the surface," said Kastner, "and then return quickly to the comfort of their support craft, which can stay on site for several weeks."

He said marine architects in his company are already designing nuclear powered tanker submarines.

"There is no better way to bring the oil out of the Arctic," he says.

"The future is in inner space," said Kastner. "There is a lot more food and mineral resources and benefits for mankind on the continental shelf than there is on Mars."

• Deep Explorer 3 and Deep Explorer 8 are two research submarines, each of which carries a pilot and two passengers on four dives a day down and across the Wall. The vessels can reach a depth of 800 feet: weather permitting, they explore the wreck of the Kirk Pride, a ship sunk at the depth of 780 feet. No experience is necessary: dives are open to everyone over the age of 8; the underwater tour takes about an hour and a half and costs $200 a person. Reservations should be made at least a week in advance through Research Submersibles Ltd., Post Office Box 1719, Grand Cayman, British West Indies (telephone: 8296 or 3870 locally, or 809-949-3870 or 809-949-8296 from overseas).

MORE RSL NEWS

Research Submersibles Limited was recently asked to arrange a submersible pilot training course for a group of 6 divers from California. The 3-day course with the deep diving Perry PC-8, was conducted offshore Grand Cayman Island. The trainee pilots received both classroom instruction and 20 hours of submersible diving to a depth of 800 ft. on the Cayman Wall.

I.S.E.
INTERNATIONAL SUBMARINE ENGINEERING LTD.
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November 26, 1985

MDG-00503-RM

Mrs. Irene Fager
ONE HALF FATHOM
4004 Bay to Bay Blvd.
Tampa, Florida 33629
U. S. A.

Dear Mrs. Fager:

Please find enclosed as per your request, several photos and a press release on the I.S.E. tourist submarines used at the West Edmonton Mall.

I have also included our most recent press release on I.S.E. 1985 sales.

In response to your questions on these specific submarines, they do completely submerge, only the conning tower remains partially above the water for safety. The submarines measure 33ft. long x 8 ft. in diameter and transport 24 passengers in a 14 minute journey through the world's largest indoor shopping center. Powered by nickel cadmium batteries, the submarines are actually self propelled and conform to American Bureau of Shipping standards. The submarines follow a mono rail underwater as a guideline for animation purposes.

From a Carribean coral reef, to shark attack, sunken treasures to the deep dark cold water creatures, the passengers witness sights of wonder, intrigue, mystery and incredible beauty.

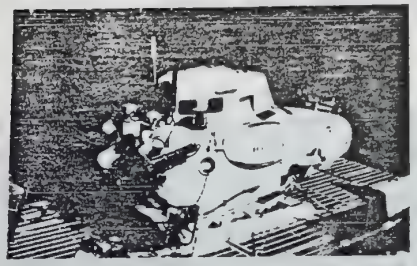
Triple Five awarded I.S.E. with this 2.5 million dollar contract because of our experience in high technology and robotic custom design. I.S.E. also participated in 9 major pieces of animation, as well as the development of the 4 submarines.

COMING SOON..... 2000 FT DIVES!

From the people who brought you the spectacular 800 ft wall dives in Grand Cayman, Research Submersibles Limited are planning to introduce a 2000 foot dive into the Cayman Trench in (illegible). RSL 2 is a 2 passenger, 1 pilot deep observation research submarine capable of diving to 3,300 ft. RSL plans 2 dives per day of 2 1/2 hours duration. The adventure would include a descent through blue water to 2000 feet and a ascent up the deep Island Slope of Grand Cayman that promises to be an experience not to be missed. The estimated cost for this very deep dive would be approximately US $ 500 per person. For more information, write RSL, P.O. Box 1719, Grand Cayman, BWI. Tel: 809/ 949-8296.

New Facilities For HURL

The National Undersea Research Program of the University of Hawaii, Hawaii Undersea Research Laboratory (HURL), which operates under a cooperative agreement with the University of Hawaii and NOAA, is on the verge of beginning a new phase in its activities with the acquisition of the submersible Pisces V that will greatly expand the scope of HURL's research programs. While the submersible Makali'i will be retained for shallower dives, the newly acquired Pisces V can dive five times deeper than the Makali'i, to a depth of 2000m, and can hold a total of three persons.



HURL's submersible, Makali'i.

Both submersibles are launched by an improved technique using a Launch, Recovery, and Transport Vehicle (LRT). The LRT is a barge-like submersible platform which transports the submersibles on the surface and is towed to the dive site by a surface support vessel. At the dive site, the LRT submerges to approximately 17m and releases the submersible with the assistance of SCUBA divers. Sherwood Maynard of HURL explains that the LRT enables safe deployment of the submersible over a wider range of sea-states and eliminates the need for a research vessel to hold and lift the submersible into the water.

HURL's submersible, Pisces V.

The three focal project areas for 1987 and beyond are the resources of the Hawaiian Islands Seamounts, the Juan de Fuca Ridge, and the West Pacific Island Arc and Back-Arc Seamounts. Gary McMurtry, Science Program Director of HURL, says that active submarine volcanoes such as Loihi in the Hawaiian Islands will be examined for hydrothermal activity and life forms that may be used in research for the possible origin of life. Reliable samplings of the older seamounts will help to determine the mining potential of cobalt, a strategic and highly priced mineral, in the ferromanganese encrustations which have attracted federal and state interest.

Juan de Fuca Ridge studies will follow up on previous research by the Alvin submersible of Woods Hole while the West Pacific project will chart new waters. This latter area is believed to be a biological threshold between the Pacific and Indian Oceans. Arc and back-arc basins will be studied to fine-scale biological data in this area and to document hydrothermalism.

Still in planning stages is a South Pacific program for 1988 that may be conducted in conjunction with the French using the submersibles Cyana and Nautile.

The HURL is currently accepting applications for time slots in the three focal project areas. McMurtry points out that while HURL can accept only 10%-20% of its proposals, it considers all proposals and ranks them according to scientific merit, in keeping with its role as one of the few submarine laboratories that provides opportunities for civilian research proposals.

For further information, contact: Dr. Gary M. McMurtry, Science Program Director, National Undersea Research Program, University of Hawaii, 1000 Pope Road, MSB 226, Honolulu, Hawaii, 96822, (808) 948-6335.

ROV Expert Publishes Second Undersea Vehicle Directory

Frank Busby, recognized world authority on remotely operated vehicles and manned submersibles, has published the long awaited second edition of his *Undersea Vehicles Directory, 1985*, this time under hard cover. Unassuming on the outside, the 504-page book is crammed with detailed specifications and photographs of 311 manned submersibles and ROVs operated by the military and industry.

His 1981 paperback edition, by some contrast, contained only 406 pages.

In addition to the 336 photographs, the directory features a worldwide summary of vehicle production activities and current applications. Included are descriptions and photographs of dedicated vehicle support ships.

Busby also has added technical discussions about current launch and retrieval techniques and the capabilities of undersea navigation techniques; a comprehensive bibliography of 474 technical papers about undersea vehicle design, capability, instrumentation, and work activities (1981-1985); another bibliography of 98 papers dealing with underwater nondestructive testing; and a product guide/directory of more than 1500 vehicle builders, operators, and equipment suppliers.

The $60 directory (U.S. and Canada, postage paid) is available from Busby Associates, Inc., 576 South 23rd St., Arlington, VA 22202; telephone (703) 892-2888.

MTS *Currents* will begin publishing regularly a list of professionals announcing persons willing to give talks on marine affairs. If you or anyone you know would be interested in participating in the MTS Speaker's Bureau, please send the speaker's name, affiliation, phone number (include area code), and a brief description of the area of expertise to the attention of Wendy Hudson at MTS Headquarters. ■

The "Fortuna", a 200-year-old sunken Spanish warship, was recently located off the coast of North Carolina with the aid of a Del Norte Trisponder positioning system. ■

Project Beebe: A Dive Forward

Deep-sea biological research will mark a significant milestone during June 1986 when the first long duration study of deep sea creatures since 1934 will commence off the coast of Bermuda. According to project member Emory Kristof of the National Geographic (MTS Underwater Photography Committee chair), the goals of **Project Beebe** are to provide a glimpse into deep-water shark habits, demonstrate that submersible operations can be feasibly accomplished on a day-trip basis, and perform a deep-water experiment for Bell Labs.

The project team consists of Kristof; Dr. Eugenie Clark, a noted ichthyologist, who is with the University of Maryland; Andre Galerne, owner of Pisces VI, the deep-sea submersible which will play a key role in this expedition; Teddy Tucker, an internationally renowned career diver; and Joe McGuiness of Canada and Jim Millrea of Bermuda who are involved in fundraising for the project.

Most of the information we have about the deep sea has been uncovered in the last 25 years. In the 1930's, naturalist William Beebe and engineer Otis Barton designed a steel bathysphere to penetrate the deep. In this crude diving bell, Beebe and Barton were winched down to a depth of 3000 feet off Bermuda making them the first human beings to come face to face with hitherto unknown creatures of the deep.

Herxanchus griseus, *or the six-gill shark*

Sharks will be the main focus of the project, but repeated manned and unmanned dives, coupled with remote baited-cameras, robot, still and video cameras, nets, traps and long lines, will yield an extensive cross-sectional portrait of the ocean's deep dwelling creatures.

Funding for the project is being supplied by the National Oceanic and Atmospheric Administration (NOAA), the National Geographic Society, and private donors based in the United States, Canada and Bermuda.

The goals of **Project Beebe** are three-fold. One is to learn more about the creatures of the deep-sea, in particular the six-gill shark (Herxanchus griseus) which has been infrequently captured. These green-eyed sharks have been measured at 14 feet but many estimate that these may have been juveniles, and that full grown adults could reach 25-30 feet.

Two revolutionary techniques will be used to capture these sharks on film and to track their movements. Thallium-iodide lights will be placed on the submersible. These green fluorescent lights are expensive, difficult to use, but effective as they are within the color spectrum of the sensitive eyes of the sharks. Because these are low lights, a proto-type RCA 1 million ASA film will be used. To track the animals, radar pingers will be put in the bait near the cameras with the assumption that the shark will swallow the bait and the pinger. A back-up method consists of using divers and long lines to place the radar manually on the shark.

Pisces VI

A second goal of **Project Beebe** is to show that submersible operations in oceanographic research can be feasibly accomplished on a day-trip basis. Generally, the costs of an oceanographic expedition can be staggering, but with Project Beebe these costs will be considerably minimized by using the Pisces VI submersible without a mother ship. The Pisces VI will be stored at the Bermuda Naval Facility and will be towed to the site of each day's exploration. For a project which could otherwise cost up to $25,000 a day, the Project Beebe team estimates their daily rate can be reduced to about $4000.

Lastly, the project team will attempt to aid Bell Labs in unravelling why sharks have been destroying new deep-sea fiber optic cables laying at the 3000 foot level in the Canary Islands. Bell Labs will give the Beebe team a 2km. cable to experiment with off Bermuda in the hope of discovering why there is such an attraction to the cable, and the type of shark destroying it. It is feasible that a new species of shark may be discovered during these experiments.

Coast Guard rescues 2 men trapped in submarine

FORT PIERCE (UPI) — Coast Guard divers Wednesday afternoon rescued two men from a small submarine that became trapped in mud 30 feet beneath the ocean surface, a spokesman said.

One of the men got to the surface under his own power when divers opened the submarine's hatch, but the other had to be pulled free. Both were taken to Lawnwood Hospital in Fort Pierce, but their conditions were not immediately available.

Petty Officer Gary Starks said in Miami that the Coast received a distress call at 12:15 p.m., saying the men were trapped inside their small, yellow submarine. They said the craft was mired in mud under 30 feet of water off South Beach.

Starks said two Coast Guard boats were sent to the scene and divers found the submarine.

Last Summer's Dives to the Depths of Lake Superior Yielded Enough Results, As Well As Surprises, to Merit Further Study

By Michael K. Clark
Assistant Editor

In a continuation of a successful study conducted in July of 1985, scientists will return to the depths of the Great Lakes this summer. The 1986 study is the latest of a multiyear program on both the theoretical and practical aspects of the chemistry of freshwater-sediment systems.

This year's exploration will be the third attempt to dive Lake Superior's depths in a scientific submarine. Famed French marine explorer Jacques Cousteau made the first attempt in 1980. That expedition, however, proved to be unsuccessful as the divers had no visibility on 19 of the 40 dives. The current series of dives differ from the first in that the Cousteau dive was general exploration and the NOAA dives are for specific scientific research projects.

In 1985 the findings were significant. Until that expedition, Superior had rarely been viewed at depths below 60 meters. Using the Harbor Branch Foundation submersible *Johnson-Sea Link II*, however, scientists were able to descend to the deepest point of the lake, 405 meters.

Some of the excitement which was generated by the findings of life at Superior's depths in last year's dives will be found once again in a new area, as special sediment camera systems will once again be utilized to detect substrate changes over short distances and allow more precise core sampling for geotechnical studies. This camera, tried and proven in the 1985 Superior dives, is operated by submersible to obtain real time video records for high frequency sampling.

Because of the success associated with the 1985 Superior dives, and similar success with a Gulf of Maine study in 1984, the studies have been authorized for southern New England to gather information to better understand the environmental factors which govern the recruitment and reproduction of shellfish.

Sea Cliff finds manganese nodules

Investigators on board the U.S. Navy's manned submersible vessel Sea Cliff recently discovered the presence of manganese nodules during a training mission 10 miles south of San Clemente Island and approximately 40 miles west of San Diego, Calif.

The nodules were found on the first of a series of cooperative missions planned for the Sea Cliff under the Navy's new policy of supporting national scientific research when possible during training missions.

Two 6-inch diameter manganese nodules were retrieved adjacent to a hydrothermal vent at the base of a large escarpment fault at a depth of approximately 6,000 feet. The discovery was made by Lieutenant Bruce Bossard of the U.S. Navy and Dr. Peter Lonsdale from Scripps Institute of Oceanography. The site had been suggested by Dr. Lonsdale, based on prior work sponsored by the Navy at Scripps.

The Sea Cliff was on a training mission near its home port of San Diego.

Scientific support for the first mission was provided by Dr. Skip Gleason from the Alvin group at Woods Hole Oceanographic Institute, Woods Hole, Massachusetts; and Dr. Robert Dill, U.S. Minerals Management Service.

Dr. Dill characterized the nodules as "good quality," but added that "they will be further analysed at the Department of the Interior's Bureau of Mines laboratory in Albany, Ore."

LT Bossard, the Sea Cliff's skipper, commented that the 32-foot 58,000 pound vessel encountered "some very harsh conditions" during its mission, including some "unusually swift currents for that depth."

Second look at Lake Superior's depths planned

EAST LANSING, Mich. (AP) — Scientists who conducted an unprecedented exploration of Lake Superior's depths now are making plans for a second look at the lake, along with a first-time foray into Lake Huron, a researcher says.

Organizers of the second month-long dive, scheduled to begin in July 1986, again have obtained a $500,000 grant from the National Oceanic and Atmospheric Administration, said William Cooper, zoology department chairman at Michigan State University.

This past summer's Lake Superior expedition involved 21 scientists who traveled and studied aboard the Seward Johnson and also made numerous dives in the Johnson Sea-Link II, a battery-powered submarine.

About two-thirds of the 1986 probe would be spent in Lake Superior and the rest in upper Lake Huron, Cooper said.

In Lake Superior, Cooper said, the researchers probably would repeat their studies of deep-water fish populations, analyses of marine life, particularly sea lampreys, and movement of water-borne chemicals.

In Lake Huron, he said, the scientists probably would study lake trout spawning and the presence of chemicals in the lake bottom — two areas covered in this past summer's expedition.

First serious scientific probe of Lake Huron to begin in July

By HUGH McCANN
The Detroit News

The first serious scientific exploration of Lake Huron will begin next month when researchers ride a tiny submarine 725 feet down to the floor of the lake.

They'll study marine life, geological features, chemical pollution and trout spawning habits. The scientists made a similar dive to the bottom of Lake Superior last year.

"Last year, we didn't know what to expect," said Michigan State University zoologist William E. Cooper, project organizer. "This year, we have a much better idea of what we'll see and be able to do."

Cooper and 27 other scientists will take turns aboard a leased sub from July 17-Aug. 10 as they gather laboratory specimens and visual evidence beneath Lakes Huron and Superior. Project participants are from Michigan State University, the University of Michigan, and seven other universities and government agencies.

"It's basically the same team as went down last year," said Coopers. The scientists — biologists, zoologists, geologists and fisheries experts — "are as excited about going down a second time as they were the first," he added.

Their schedule calls for five days under Lake Huron and 16 under Lake Superior.

Researchers expect to find differences between the lakes. As you get farther south, he explained, you get closer to human habitation. That means there should be some differences in Huron's water quality. He attributed this to runoff from farms and pollution from heavy industry.

When the scientists made their first dive in Lake Superior, the deepest of the Great Lakes, they risked crushing pressures on the bubble canopy of the Johnson Sea-Link II research submarine. They descended silently through murky half-light to almost-total darkness at depths greater than 1,300 feet.

High-powered lights illuminated Superior's strange, pock-marked lake bed — a sight that took the specialists by surprise. They marveled at towering, iron-rich formations of vividly colored sandstone and were impressed by wide valleys scattered with massive boulders.

This summer's team — it includes nine scientists from the University of Wisconsin, eight from Michigan State and and four from the university of Michigan — will make its first dive in Lake Huron July 17 in Sea-Link II, a scientific vessel leased from Harbor Branch Foundation of Fort Pierce, Fla.

The 22-foot craft recently returned from the Florida coast, where it helped recover the wreckage of the Challenger shuttle.

Regions targeted in the second phase of the Superior exploration include the Caribou Trench, near the Canadian shore, about 50 miles north of Sault Ste. Marie. Cooper has scheduled nine days of diving there.

"It's about the deepest part of the lake," said Cooper. "We were down there last year. It's a large trench dug out, we think, by the lobe (projection) on a glacier. It has lots of neat geology and lots of marine critters."

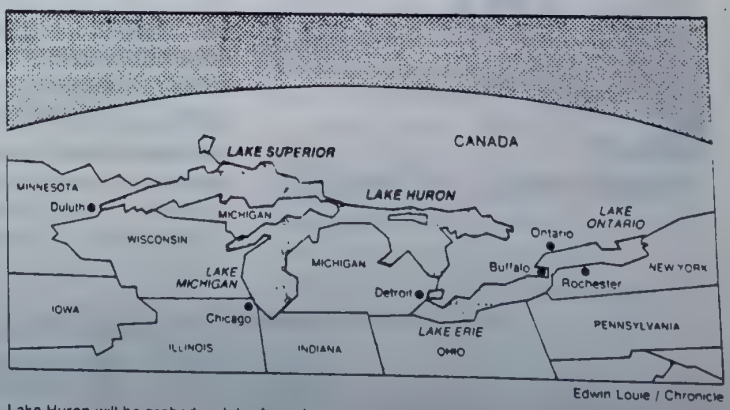
Last summer, scientists were unprepared for several things they found under Lake Superior's cold surface. One was the abundance of fish and other life forms at depths below 1,000 feet, where lack of light stunts plant growth which feeds marine life.

Few marine specimens were recovered during the dives in Superior because of lack of equipment. This time baited fish traps and electric shockers will help gather samples.

Scientists also will direct a U.S. Fish and Wildlife Service trawler capable of netting fish at depths of 600 feet.

The scientists are particularly interested in a six-inch fish called sculpin found throughout the lower depths of Superior. The sculpin scoops shallow holes in clay segment, pocking the lake floor.

Researchers also want to compare Huron's lake trout spawning regions with those of Superior.



Edwin Louie / Chronicle

Lake Huron will be probed in July. A similar probe of Lake Superior's bottom was made in 1985.

Chemical Energy Sustains Life at Ocean Depths

Marine researchers at the University of California, Santa Barbara have reported the first direct ocean measurements confirming that marine communities in extreme ocean depths rely on chemical rather than solar energy.

In the March 7 issue of *Science*, the scientists describe an extensive series of measurements of sulfur and oxygen concentrations in the waters of a marine community at a deep-sea hydrothermal vent. These measurements, the first chemical analyses performed in "real time" in the deep ocean, clearly support the supposition that the creatures in this lightless realm rely on the sulfur and oxygen in the mineral-rich hydrothermal water for the energy required to sustain life.

Until 1977 sunlight was considered the sole energy source for virtually all higher life forms on Earth. But then exploration of the deep-sea floor off the Galapagos revealed a series of luxuriant oases of marine life in the Stygian blackness more than 250 meters beneath the waves where none should have existed. Unusual communities of giant and showy tube worms, mussels, clams and crabs clustered around hydrothermal vents, areas where hot, mineral-rich waters bubble up from the sea floor.

Since the initial discovery, similar chemically powered organisms have been found in a sewage outfall off Los Angeles, natural gas seeps in the Gulf of Mexico, submarine springs in the waters off Florida, in the Santa Barbara Channel and other similarly non-exotic settings. The ecology of these peculiar colonies, however, have remained shrouded in mystery.

Scientists Find Unique Community Living on Atlantic Seafloor

Scientists for the international Ocean Drilling Program have returned from a two-month drilling expedition in the Atlantic Ocean with samples of a unique biological community they found living amid 10-meter-high chimney structures that spew hot, metal-enriched fluids onto the seafloor.

Their ship, *JOIDES Resolution,* was the first ever to collect core samples adjacent to Atlantic Ocean smokers, a system of underwater hot springs that produce rich deposits of ore on the ocean floor.

"We were using an underwater camera at about 3,000 meters below the surface of the water in an area of suspected hydrothermal activity when we first saw these little creatures swimming in and out of view in an actual black smoker area," said Dr. Andrew C. Adamson, Texas A&M University staff scientist. Texas A&M is the headquarters for the Ocean Drilling project.

"There were shrimp-like crustaceans of various sizes swimming around and small organisms, possibly anemones, that attached themselves to the rocks of the seafloor," Adamson said. "This community, which consists of mostly small, mobile organisms, differs from the hydrothermal communities in the Pacific, which are known for their large, polyp-like tubeworms, clams and mussels."

Intrigued by the creatures, researchers on the ship improvised a biological sampling device that could be towed along with one of the cameras.

"We had some delays in getting the sampling device back on board, so we lost many of our specimens, but we were able to collect and preserve a few small crustaceans, some pinkish shrimp-like creatures and a deep sea fish," Adamson said.

These samples and the video will be taken to Woods Hole Oceanographic Institution of Massachusetts for further study, he said.

The cameras also gave scientists a firsthand look at a submarine hydrothermal vent system in the Mid-Atlantic Ridge, an underwater volcanic mountain range that encircles the world. Cold sea water circulating down into hot, recently erupted lava is heated to high temperatures in these hydrothermal vents and is upwelled as hot springs onto the seafloor.

Marine geologists are particularly interested in these hydrothermal systems because of their ore-producing capabilities.

This is only the second time that scientists on board a research vessel have observed active hydrothermal vents in the Atlantic Ocean. Samples recovered during drilling included black sand and gravel composed mostly of copper, zinc and iron sulfides, as well as massive nuggets of iron and copper sulfides. Scientists studying these deposits will be able to enhance our understanding of how the circulation of seawater through hot, volcanic rocks leaches metals and concentrates them into ore deposits. /st/

Exotic secrets of the deep revealed

United Press International

WASHINGTON — A scientist whose tiny submarine dived more than two miles into the Atlantic Ocean reported yesterday the discovery of dense black smoke geysers, exotic marine life and rare metal deposits on the boiling sea bottom.

Peter Rona of the National Oceanic and Atmospheric Administration told a news conference that the undersea expedition he headed in May and June some 1,800 miles east of Miami resulted in "the first direct inspection of hot black smoke geysers in the Atlantic." The phenomenon previously only had been found in 1979 in the Pacific Ocean.

Scientists then decided to go down and take a close look.

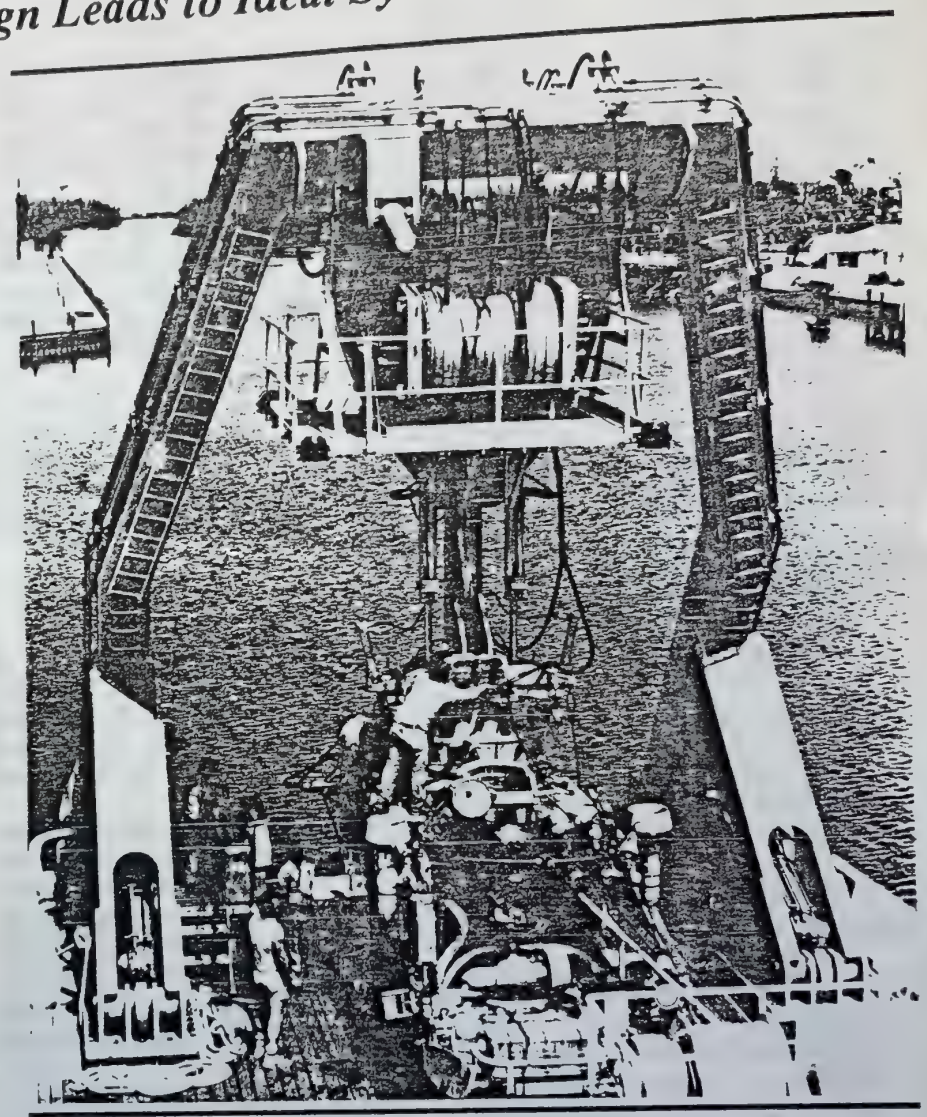
The three-man submersible Alvin was lowered to 12,045 feet May 16 and, Rona said, "We found a massive mound, the length of two football fields and the height of the Statue of Liberty, composed of polymetallic sulfides." He estimated the weight of the mound at 4.5 million metric tons "and still growing."

The Atlantic geysers, he said, were first located by a surface research vessel at 26 degrees north latitude, 26 degrees west longitude — midway between Florida and the northwest coast of Africa.

The A-Frame: State of the Art in Submersible Launch and Recovery

Employment of the Latest Innovations in Technology and Design Leads to Ideal System

By Andrew M. Clark
Head, Mechanical Engineering Department
Harbor Branch Foundation



The design and construction of their state-of-the-art research vessel, the *R/V Seward Johnson*, levied a mandate on Harbor Branch Foundation's (HBF) Ocean Engineering Division: Provide the vessel with an equally advanced submersible handling system for launch and recovery of their two *Johnson-Sea-Link* manned submersibles.

Having designed and fabricated submersible handling systems in the past, HBF engineers were faced with the classic "buy or build" decision. The answer, it appears, was to do both.

Over ten virtually maintenance-free years experience, totaling more than 2,000 successful *Johnson-Sea-Link* launch and recovery operations using aluminum-built articulated cranes, led HBF to place two requirements on the system installed onboard the *R/V Seward Johnson:* (1) Capability of handling a heavier submersible in more hostile seas and (2) aluminum construction.

With plans at HBF to construct a heavier (36,000 lb), deeper diving (2400 meters) submersible, the need for an upwardly compatible handling system was apparent. An ascent from 2400 meters can provide sufficient time for sea states to double in force beyond original launch conditions. The weight of such a system becomes a significant factor on a support vessel of this size (54 meters, 300 tons)—and minimal maintanence is a concern of the six-man crew.

The submersible support ship's trans-oceanic capability dictated a handling system designed for world-wide operation. While HBF has amassed an impressive track record of launch and recovery operations with their articulated cranes in the waters of the Caribbean and eastern North America, it was deemed prudent to benefit from the experience of over a decade of submersible operations in the hostile environment of the North Sea. Evaluation of needs, both recognized and anticipated, indicated that a hybrid system—incorporating the North Sea-proven hydraulic control system developed by Caley Hydraulics Ltd., Glasgow, Scotland—and the light-

weight, low-maintenance, all-aluminum construction characteristics of the HBF articulated hydrocranes was the optimum solution.

Problems Encountered

The problem at hand is to launch and recover the submersible safely with a system that has reliability and failure back-up modes, and which greatly increases the available weather corridor. The system must be operator friendly with minimal dependence, if any, on the submersible's crew and operation.

Typically, hydrodynamic characteristics of submersible and support ship differ vastly. Indiscriminate coupling of these independently oscillating bodies can wreak havoc on the submersible, support ship, and the handling system itself.

An initial investigation into the problem of launch and recovery showed a substantial number of crewmen were required during the operation, and coordination could fail in bad weather. It became obvious that one man on board the support vessel should have control. There should be no need to rely on deck crew with steadying lines, secondary winches, fenders or other devices to help control a fragile submersible swinging in the air or surging in a restricted docking well.

Ideal Solutions

A survey of commercially available systems indicated that an A-Frame system developed by Caley, primarily for hostile North Sea operations, came closest to meeting the requirements. Having been designed for sizeable North Sea vessels, the Caley systems built to date are of steel construction, and accordingly heavy. In order to meet the lightweight and low maintenance requirements, HBF and Caley agreed to embark on a joint venture. Caley would supply the entire hydraulic control system, and HBF, with years of aluminum fabrication expertise, would design and build the actual A-Frame structure and cylinder support bases.

Structural Design

The 915-meter design depth *Johnson-Sea-Link*-classed submersibles weigh only 12 tons each. Anticipation of HBF's 2,400-meter, 18 ton submersible currently under design required a handling system capable of substantially higher loads. In fact, the handling system was actually designed with the capacity to launch and recover the U.S. Navy's DSV submersibles. While the system is capable of handling the 27 ton DSVs, its rated capacity is currently set at 18 tons. Based on American Bureau of Shipping (ABS) design rules this is the maximum rated capacity which can be verified using strictly numerical analysis.

The submersible, *Johnson Sea-Link*, is suspended above the water by the A-Frame onboard the *R/V Seward Johnson* as the research vessel holds its position at sea.

Design of the handling system was concurrent with the design of the ship itself. This enabled HBF engineers to supply the ship's designers with anticipated deck reactions and moments in order that appropriate fortification for the handling system foundation be incorporated into the ship's structure.

A refined model of the A-Frame was created using 3-D isoparametric brick-type elements. This model was based on the section modulus information derived from a simple beam model resembling a stick figure. The refined model allowed close evaluation of the placement of particular stiffening members and bulkheads.

Control Design

As engineers of specialized marine hydraulic control systems, Caley had no difficulty in choosing a closed loop, high pressure hydraulic system with proportional control and near 100% redundancy as the best way to power the system.

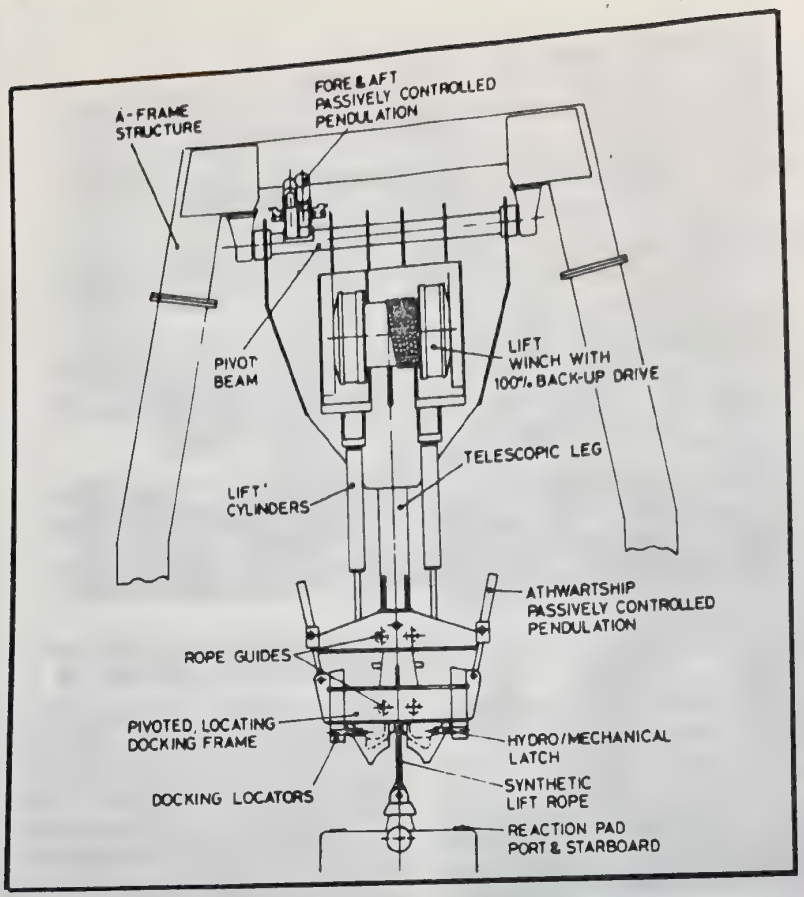
Special attention was given to built-in safety and hydraulic control of the substantial operating cylinders. A single lift point was identified as being practical. It is quick to release and attach, less likely to snag or interact with other lift lines, and the elastic properties of the synthetic braided line help cope with shock load transients.

Optimum placement of the low inertial lift winch proved to be pivoted under the A-Frame's top beam, beneath a hydraulic system which passively controls pendulation fore and aft. Positioning the winch here conserves valuable deck space, installation time and costs, and dispenses with the need to cope with the lift line during A-Frame movement.

Construction Details

Arriving at the optimum structural design required a considerable engineering effort, but HBF is well equipped for such an undertaking. The fabrication facility at HBF, however, was not geared for construction on this scale. A certain amount of ingenuity was required in order to accomplish this task with the limited resources available.

The 20 plus tons of plate, much of which was 6 centimenters thick, used in the structure was cut. The fabrication facility at HBF is not equipped with an overhead crane. Therefore, the massive structure was built in sub-assemblies which could be han-



The diagram of Caley Hydraulics patented control system.

dled with fork trucks or "cherry picker" type portable cranes.

The A-Frame and bases were welded using the GMAW process. The subassemblies' manageable size enabled them to be positioned such that most welding could be done in the flat or horizontal positions. This minimized the number of less desirable and more difficult overhead or vertical welds. However, many of the novel design features which enhanced the strength and stiffness characteristics of the structure also proved to create some unfavorable situations for the welders.

Only after all the major welding and associated distortion was completed could the assemblies be machined. The machine works in Scotland where Caley has built some 20 of these systems from steel is equipped not only with substantial overhead cranes, but also with a milling machine of aircraft hanger proportions.

This was perhaps the smoothest installation of an A-Frame onboard a ship in history. This was largely attributed to the fact that the A-Frame and ship were designed for each other, as was previously discussed.

The aluminum A-Frame and base structures represent a savings in weight greater than 50% over a comparably rated steel handling system. The handling system has been in service for over one year. It has provided safe and reliable service in launch and recovery operations from the Great Lakes to the Central American coast. The entire launch and recovery operation is controlled by one man, from a console inboard of the starboard base. The tow winch, located on 01 deck, maintains tension on the submersible during its transit through the air thus restricting yaw and pitch, in addition to performing its main function of towing the submersible to the recovery position behind the ship.

On recovery, a swimmer must enter the water to attach the tow line to the submersible, and guide the lift line into its receptacle. Both the tow hook and lift line receptacle (Drop Lock) are pneumatically actuated by the submersible pilot, thereby eliminating the need of a swimmer on launch.

The Way Ahead

In order to upgrade the handling system's ABS rated capacity to its full design capacity, a program is underway at HBF to determine experimentally the actual operational loads. The information can be brought back to the laboratory for evaluation and comparison with the computer simulated model. The data acquisition system described has already been developed and tested.

It is anticipated that the empirical results will corroborate the numerical projections, thereby enabling a reclassification of the system to an ABS rated capacity of 27 tons. This will enable the *R/V Seward Johnson* to serve as a back-up support vessel for the U.S. Navy's DSV program. The main cylinders for inboard/outboard A-Frame travel were sized in anticipation of this goal.

At-sea experience, combined with computer simulation and resources such as Caley's purpose-built 100 ton dynamic test facility, become invaluable when considering the future challenge. Adopting aluminum alloys and performing extensive structural analysis employing FEM modeling enabled a weight savings (over steel) on the HBF/Caley structure of more than 50%. Weight economy on this scale becomes even more attractive when applied to more portable "fly away" ROV systems. In addition, the marine series aluminum alloys provide a structure requiring no painting, minimal maintenance, and simplified structural monitoring.

The HBF/Caley system represents the state-of-the-art in launch and recovery systems.

Present designs are reducing the reliance on surface diver support. Serious consideration is being given to designs which eliminate the need for diver support on recovery. There seems to be a good future for the fast surface support vessel capable of launching and recovering submersibles in a hostile environment. Lastly, but of utmost importance, there is much to be gained by closer cooperation between submersible operators and deployment designers. st

Andrew M. Clark is currently involved in Harbor Branch's development of an ROV system for marine science research. He is the recipient of a bachelor of science degree in ocean engineering and a master of science in engineering from Florida Atlantic University.

Submersible Systems for Ecological Research in Polar Regions

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ABSTRACT

Submersibles offer an exciting opportunity for future investigation of ecosystem processes in Arctic and sub-Arctic environments. Past experience has demonstrated not only the feasibility of manned and unmanned submersible operations under sea ice, but also the unique capabilities for data collection in these otherwise largely inaccessible habitats which are being recognized as playing a major role in supporting living resources. Greater priority needs to be given to both ROV's and manned submersibles dedicated to scientific research in the polar regions.

INTRODUCTION

Any consideration of the future of Arctic engineering must be based on predictions of what the central issues will be. There is little doubt that resource depletion will then be critical, to a degree hardly experienced now. Further, living resources (that is, those that are renewable and, hopefully, sustainable) must top our priority list. However, what is to assure the sustainability of living resources? This question relates to politics and socioeconomic needs, but fundamentally requires no less than a focus on long-term ecological research; that is, concentration on the processes that drive ecosystems. This paper emphasizes some contributions that can be made by research submersibles towards these ends in polar regions, particularly those rich and productive seas dominated by seasonal sea ice.

ARCTIC ECOSYSTEMS

Reichle et al.[1] have succinctly described some ecosystem characteristics, including maximum persistent biomass, an energy base, an energy reservoir, element recycling, rate regulation, metabolism, and succession. These are all difficult to investigate and reorienting research towards such features requires major effort, good will, and—needless to say—funding. Until very recently, in fact, the greater proportion of marine scientists would probably have asserted the impossibility of holistic ecosystem research and management, involving all trophic levels. But it may well be that we are on the verge of monitoring ecosystem processes; predictability is almost sure to follow.

A Symposium on Variability and Management of Large Marine Ecosystems (LMEs) was held in May 1984 at the Annual Meeting of the American Association for the Advancement of Science. In addition to those points mentioned above, several participants called for the integration of data at several scales and the need for non-traditional data. This represents a strong shift in emphasis for many marine scientists and is based on the thesis that large marine systems are coherent, functional units of the natural world that can only be understood and managed on that basis. This is very much in contrast with the traditional separation of oceanography, marine biology, and fisheries into disciplines and institutions that serve more narrow purposes. Nevertheless, the outreach of ecosystem concepts still has a long way to go toward implementation. This is especially so in polar seas, which still challenge us, more than elsewhere, to work productively and efficiently within them. No reasonable person would now doubt the essential role to be played by submersibles, both manned and unmanned, in helping to meet this challenge. Yet, for sea ice-dominated seas, the application of submersibles is generally overlooked.

PAST USES OF SUBMERSIBLES FOR POLAR RESEARCH

Quite a large literature now exists on submersibles, their design and capabilities, and their past uses.[2,3,4] In 1968, the author was privileged to be asked by Dr. A.R. Milne of the Defense Research Establishment Pacific, Canada, to join him and his team aboard the icebreaker *Labrador* for scientific work in northern Canada; the submersible *Pisces* (Figure 1) was to be used beneath the ice to help locate instrumentation deployed the previous year on the bottom.

This operation was quite successful, and it prompted a request for support from the United States Navy and NOAA's Manned Undersea Science and Technology program (now the Office of Undersea Research) to use the Perry *PC-8b* under the sea ice of the Bering Sea in late winter, 1972, with the U.S. Coast Guard's *Burton Island* supplying the support platform.[5] (Figure 2) Although, this operation did not go as smoothly as that of the *Pisces* (largely due to the inexperience of all involved) it did result in at least one new observation and a resulting hypothesis. The author vividly recalls an Sam Stoker, emerging from the *PC-8b*'s hatch, exclaiming: "The bottom looks as if a bunch of pigs had been at it!" (Figure 3). These observations confirmed what we had long suspected; the bioturbations—a word

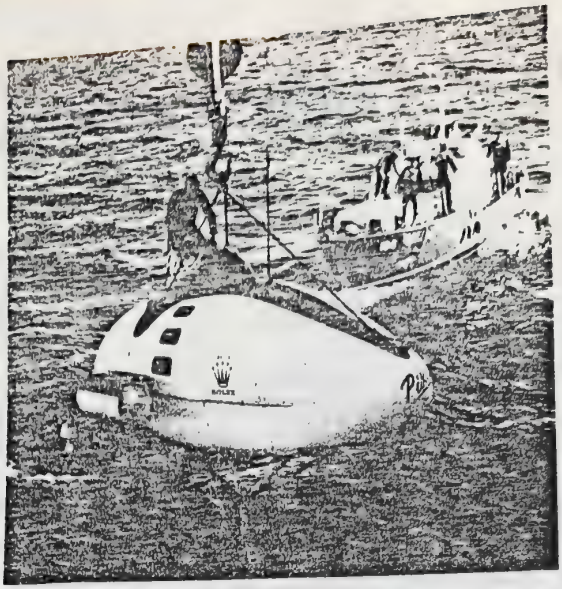


Figure 1. *The* Pisces *being lowered into the water near Thule, Greenland, in 1968. Dives were up to about 325 m in the waters of the Canadian Archipelago, beneath ice of about 2 m. thickness.*

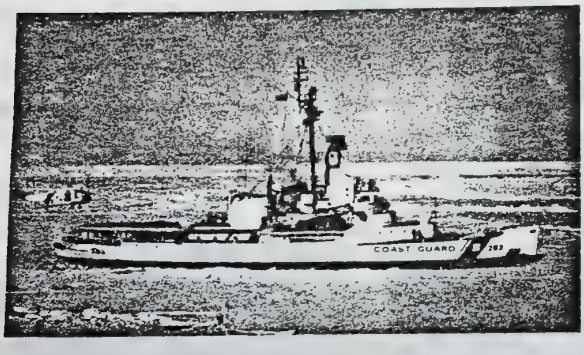


Figure 2(a). *The U.S. Coast Guard icebreaker* Burton Island *in the north central Bering Sea in March 1972. The plastic housing for the PC-8b is the dark object just aft of and below the bridge.*

Figure 2(b). *The PC-8b in a polynya (lake-like opening in an ice field) with newly formed sea ice. Dives were up to about 60 m. under ice of about 1.5 m thickness.*

Figure 3(a). *A pit presumably made by a walrus feeding on a shellfish. The pit was at about 55 m depth and was about 30 cm diameter.*

Figure 3(b). *A furrow presumably made by a walrus searching for shellfish. The furrow was about 25 cm across and at least 5 m long. It was at about 55 m depth.*

describing biological disturbance of the bottom—that result from the benthic feeding activities of walruses[5] no doubt have important ecological consequences. As a result of these observations, the vital role that could be played by submersibles in making such observations in Arctic waters became quite clear. Indeed, submersibles represent important observational tools and a means by which to validate or deny data achieved by more remote methods.

Since that time, there have been several notable sub-ice biological and ecological investigations, both in the Arctic and Antarctic, but apparently none that have involved submersibles. NOAA's Office of Undersea Research has, in fact, established that manned activities under sea ice will not be supported by them, although remotely-operated vehicles (ROV's) may be. This is based on two factors: first, normal safety procedures no longer pertain to under sea ice and, second, the scientific community has not yet made a

strong enough case to justify engineering and other studies toward this end. However, there exists a growing awareness of the potential of submersibles and recent, exciting developments in remote instrumentation for use by scientists at work in high latitudes. The Bedford Institute of Oceanography seems to be the present leader in this respect with both the *Dolphin*[6] and the *ARCS*[7] well on their way.

OPERATIONS IN SEA ICE

There exists very little in the way of guidelines and criteria for applications of submersibles in polar seas. The recently published, *Operational Guidelines for ROV's* provides only a brief "forecast" of "Arctic Applications." It states, in its entirety: *"The Arctic, as it becomes more important to the oil and gas industry and to military defense, will provide a fertile environment for both tethered and untethered systems. For example, a recent study (1983) to determine the usefulness of ROVs and AUVs for measuring underice topography and roughness suggests that tethered, free-swimming ROVs might be useful for a coverage up to about one square mile. This is but one application of ROV technology.*

There are several research efforts to extend ROV technology to Arctic applications. The University of Washington UARS vehicle is one such experimental ROV. The AIMS vehicle of the University of New Hampshire is another. Both of these are designed for experimental efforts, with little likelihood of commercial applications in the near future.

There is considerable interest in placing side-scan sonar systems aboard an ROV (probably untethered) to expand the capability to evaluate under ice structures and seafloor topography. It is likely that these experimental vehicles will continue to evolve."

One can only hope that the last statement is true. Side-scan sonar is the very instrument most useful to give regional dimension to the walrus bioturbations that were first noted in 1972. Recently, Oliver et al.[8], using scuba, observed similar benthic features, attributable to walruses, that were seen from the *PC-8b* a decade previously. However, no observations to date can determine the spatial—and therefore ecological—importance of walrus feeding. Moreover, the walrus is not the only diving animal which disturbs the bot-

that were first noted in 1972. Recently, Oliver et al.,[8]

whales (*Eschrichtius robustus*) also feed on benthic organisms. The combined effects may be massive. For example, K.R. Johnson and C.H. Nelson[9] estimated, by means of side-scan sonar data, that gray whales may perturb over 22,000 km² of benthic sediments per year in the northern Bering Sea alone. Nerini and Oliver[10] and Oliver et al.,[11] again using scuba, have also observed depressions on the sea floor that appear to give credibility to the side-scan data. The potential impacts of these marine mammal feeding activities are discussed below. Past activities by manned submersibles and scuba have given us point source data on possibly important feeding activities. More to the point, just over the horizon are submersibles, carrying side-scan sonar and other sensors, that can yield confirmation and essential synoptic data, even under sea ice, that will allow better ecological interpretations.

For this history, it is pertinent to point out several aspects of under-ice operations. The recent *Operational Guidelines for ROV's* included an appendix on "Arctic Environmental Conditions" which provides some insight into the constraints one faces in polar regions. The problems of operating under or around sea ice seem to loom large, but there are also advantages. Most notably, sea state often approximates a mill pond, as there is little fetch over the leads and polynyas that comprise the open waters of an ice field (Figure 4). Thus, logistics platforms can operate under very stable and predictable conditions. Second, sea ice is not everywhere the same, nor is its horizontal stability more than apparent. Sea ice is of a variety of thicknesses, types, hardnesses, and coverage (Figure 5) and is almost always on the move, at a rate of from about 10 to over 40 km/day. Even the most powerful icebreakers can be helpless against the forces involved. Whereas the ship may appear stable in its posi-

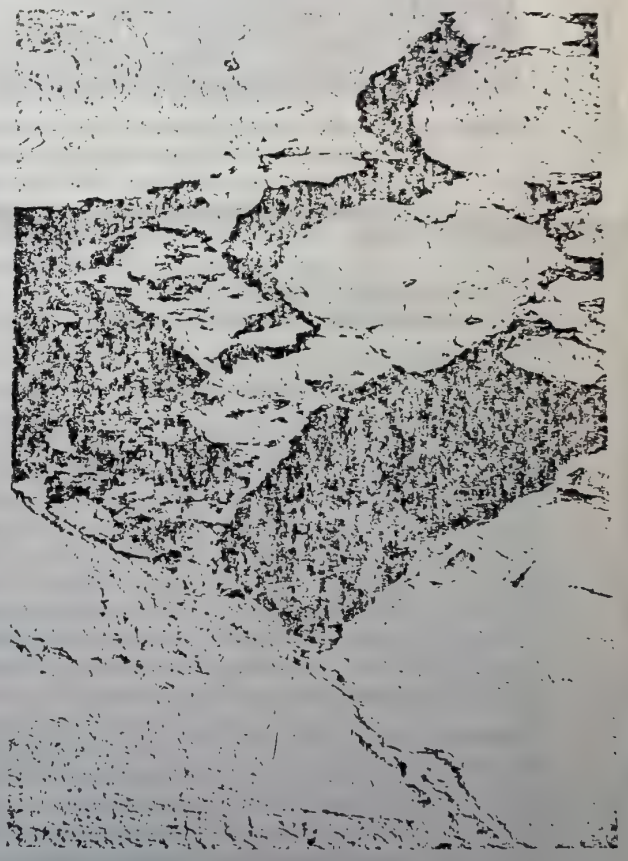


Figure 4. *A portion of the ice field of the north central Bering Sea in late winter. Ice of up to 1.5 m is white and has pressure ridges of much greater thickness. Open water of leads and polynyas may contain newly formed, very thin, soft ice.*

Figure 5. *NOAA weather satellite image of early winter sea ice of the Bering and southern Chukchi Seas. The ice field is highly variable, containing ice of up to 1.5 m and large open water polynyas. The boundary of the ice field (NW to SE) approximates that of the Bering Sea shelf.*

tion in the field of ice, it is moving with respect to the bottom. A submersible placed underwater will almost surely find an altered ice environment at the time of recovery. The support ship will also be in a different position. Related to this is the third point: that excursions and transects must be made by the submersible independent of the support platform, which is best left stationary with respect to the moving ice. At least one ROV, the *ARCS*[7] is specifically designed with extensive sub-ice excursions in mind, possibly to 8 km. in length. There are no doubt others on the drawing boards, and their technology could probably be applied to manned submersibles as well.

The final point concerns whether manned or unmanned applications are most promising. There really is no answer to this from the scientific point of view; it depends almost entirely on the objective to be pursued. There are things a machine does better than a person and vice versa. A rule of thumb should be that if the machine is better, use it, but do not try to force a machine to do what a person does best. This seems obvious, but is often forgotten. It may seem adventurous to go "manned," but is it efficient? Conversely, scientists are often forced to "make do" with instruments when their own hands and eyes are better suited to the task. A ruling against manned subm... bles under sea ice, for example, could force scien... to use other than their best instrumentation—name... their own observational and collecting powers—for... investigations of benthic phenomena. It also creates a rather contradictory situation in which divers will continue their subice work, possibly at even more hazard than they would be exposed to in a submersible—and surely not as productively or as deeply—while manned submersibles remain off limits. This is not to say that present safety rulings should be eliminated, but rather that they should be faced and solutions found.

CASE STUDY

To give perspective to how a submersible might fit into the suite of technology required for an ecosystem-based study in an Arctic environment, a description of the Bering Sea shelf system is appropriate. The marine mammal bioturbations are interesting to a specialist in marine mammals or to benthic community ecology, but such may not be their major significance. What can our observations of such phenomena tell us about the spatial dimension that would give important ecological significance to walruses, seals, or whales? That is, is the impact of their feeding great enough to affect their ecosystem? In a recent paper[12] (1981) the author has noted that top ocean predators may influence ecosystems in various ways. But can their activities be measured and, if so, how?

The Bering Sea is extraordinarily rich and supports as great a density of fishes, mammals, and birds as anywhere on earth. Mammals and birds, being warm-blooded and energetically very demanding, are particularly good indicators—witness their abundance in other productive seas, as the Humboldt Current and the Southern Ocean. However, mechanisms for high oceanic productivity have only recently been revealed and still must be regarded as hypothetical in many respects. Two features of the Bering Sea are immediately apparent: a very wide shelf and the presence of seasonal sea ice over most of the shelf (Figure 5). Walsh[13] has provocatively examined the Bering shelf in a comparative way and points out that carbon is cycled quite differently over shelves than in the open sea with possibly significant consequences for the total global carbon budget. Although the exact mechanisms are far from being understood, how carbon is handled does appear to be paramount to understanding these shelf ecosystems.

Few natural events are so striking as the annual advance and retreat of sea ice. This seasonal cycle dramatically alters the nature of the underlying waters and their fauna. A primary question concerns the role of sea ice in productivity. One hypothesis concerns how the integrating and focusing effects of meteorological and oceanographic events operate to produce phytoplankton blooms in the marginal ice zone. A concomitant hypothesis concerns the role of consumers—particularly benthic feeders—as recycling agents and "keystone" species that can alter the states

of their biological communities. Alexander and Niebauer[14] point out that the annual pulse of primary productivity is strongly linked to sea ice. Iverson et al.[15] have shown that benthic and pelagic systems are separated at about the 100 m isobath. The probable reason for this is suggested by Cooney[16] to be the failure of zooplankton to winter over in mid-shelf waters; thus, primary production sinks to benthic consumers such as shellfish, or is lost in a sediment "sink." The exact relationship of benthic fauna to primary productivity is not known[17], but it is probable that clams and other benthic creatures form a part of this benthic "sink," analogously to the dependency of soil organisms to soil inorganics.

It is no surprise, therefore, that benthic feeders are abundant in the mid-shelf. The gray whale undertakes the longest migration of any mammal on earth—from Mexico to the Bering and Chukchi Seas—to benefit from the food present at these high latitudes. The walrus and bearded seal are continuous residents. All three, in addition to many birds and invertebrates, feed heavily on benthic organisms. The question is: What are the consequences? Are nutrients cycled to the extent that the carbon budget is significantly altered? Are benthic communities so altered that the entire ecosystem is in a different state than it would be without these consumers? (This is the meaning behind the concept of "keystone"). Does bioturbation associated with feeding alter sedimentation rates and patterns and release entrained nutrients? One might be tempted not to treat these questions so seriously unless one took the extent of these feeding activities into account. We have no direct data, but by means of knowledge about the size of the walrus population, its distribution, and metabolic requirements, we calculate that walruses perturb at least 75,000 km² of sediments annually. This should not be ignored in any consideration of ecological processes of the Bering shelf. The scientifically exciting feature about benthic feeding is that grazing and ingestion mechanisms are much more easily observed and measured than are the feeding relationships of open-water species. Furthermore, the tool of choice is, obviously, the submersible. Thus, the submersible's contribution can certainly provide insight into the ecosystem impact of large marine consumers—a component of marine science that is extremely intractable.

LAYER CAKE TECHNOLOGY

There is such a range of interlocking problems in need of study in the Bering Sea that a whole suite of integrated technologies is mandatory. The submersible becomes part of this suite, rather than its own raison d'etre. The data achieved by submersibles can only have regional—that is, ecosystem—significance when combined with data from ships, side-scan sonar, and satellites, to name a few. Equally, ship-derived data, if restricted to dredges, grabs, water samples, and the like, need synergism with submersible data to yield validity to some kinds of sampling.

The means by which such large marine ecosystems can be investigated most fruitfully can be visualized as a layer cake with multiple feedbacks. On top is the synoptic perspective of the satellite which can best see the spatial dimensions and dynamics, e.g., how weather systems influence the distribution of sea ice. "Ground truth" for satellites is often best supplied by remote-sensing aircraft equipped with homologous sensors, but capable of better resolution. Surface ships, the traditional tools of the oceanographer, are best for surface measurements and can best yield "ground truth" for satellites and aircraft; their serious shortcomings have to do with their very poor ability to cover large areas in the short times needed to shed light on short-term events and patchiness. Ships also are capable of sampling from the water column and the benthos, but what "ground truth" best serves to validate these data?

Several recent submersible operations reveal how easily we may be being misled by surface-derived data. Herman[18] used an underwater plankton sampler called the *"Batfish"* to measure the variances inherent in ship-based sampling strategies. Robison[19] used the one-man submersible, *WASP*, to discover an extraordinarily dense copepod layer, order of magnitude differences in plankton abundances than revealed by trawls, and new biological associations and behavioral data. These are but two examples of how the submersible and its allies must become fully integrated with other oceanographic tools. None alone will suffice. Unfortunately, polar research programs have been slow to include submersibles as full partners in the store of technology and logistics. In short, the design of research ships without submersible capability seems as naive today as would the lack of a CTD. This is as true for polar regions as elsewhere.

CONCLUSIONS

From the perspective of three decades of underwater observations, in all manner of contraptions, and from polar regions to the tropics, there seems to exist a compromise between the future and the past. In earlier, more innocent times, science dominated and restrictions were few. Now we are more sophisticated and, knowing of the physiological and technological and logistic hazards, we have become justifiably more cautious. Submersible activities, furthermore, have become dominated by the search for and exploitation of offshore minerals, oil, and gas, and by certain military applications. This is so much the case that present submersibles, with very notable exceptions, may be just fine for welding and tightening bolts, but cannot get much of a grip on biological sampling. The Johnson Sea Link, with its abilities for documentation and serial sampling, and certain ROVs now in development and testing, provide the few exceptions, as far as the author has been able to discover. In the Arctic, it would appear, in short, that the author's fortunate experiences of more than a decade ago were "ice-breaking," but, since then, opportunities have become more frozen over.

This perspective, far from being discouraging, cries opportunity. We now are much more capable of providing guidelines and criteria for future submersibles for science in polar regions. Some of these are:

- good serial collecting ability by a variety of means, with samples individually labelled;
- good photographic ability;
- multiple remote sensing capabilities (e.g., side-scan sonar and acoustic tracking);
- good range, endurance, and speed;
- adequate sub-ice orientation and navigation;
- high transportability;
- reasonable cost;
- capability for long sub-ice transects;
- capability to perform *in situ* experiments; and
- capability for association with a variety of support ships.

With respect to ship support, one should emphasize the unfortunate situation that presently exists. Polar seas are the only oceans for which the United States has no dedicated scientific research vessel. Coast Guard icebreakers are provided from time to time, but cannot be classed in the same category as the research vessels of the National Science Foundation's University National Oceanographic Laboratory System. Obviously, without adequate ship support, submersible operations in sea ice are not feasible, except perhaps in the marginal ice where so-called "ice-strengthened" ships may operate. This does not totally defeat submersible operations in polar seas, for there is always the ice-free season in which to work. Still, it is a serious deterrent to good science. Therefore, ship criteria should also be taken into account. Elsner and Leiby[20] provide the following general guidelines for a research icebreaker:

- safety, simplicity, and reliability;
- seakeeping and ice-worthiness;
- range, endurance, and speed; and
- arrangement and scientific capability.

With respect to the last, their scientist to crew ratio is about 1:1; Coast Guard ice-breakers operate at about 1:20, which explains why they can not be dedicated to science to the extent that one might wish.

Clearly, a major focus needs to be placed on undersea research in polar seas in order to give added dimension and validity to existing findings. Commercial developments are encouraging the incentive to provide new tools that could be used for this purpose. Nevertheless, most of these will not be of much use for science. Submersible development is mostly driven nowadays by commerce and technology; the scientist's need is to test hypotheses. That science is not a strong driving force in submersible design is abundantly apparent when one inspects the recent submersible literature. NOAA's Office of Undersea Research and the Division of Polar Programs of NSF could go a long way toward offsetting this, but there appears to be little activity in this regard at present. The burden is, undoubtedly, on the scientific community to demonstrate the need, in consort.

The importance of polar seas, especially those described herein that are characterized by seasonal sea ice, is based on several grounds—science, economics, industry, and military uses. A major focus of economic activity is fisheries and the abundance of non-commercial living resources of both ecological and social value. We know much too little of these resources to be able to assure their sustainability in the face of logarithmic population growth and development. Submersibles, as parts of total research systems, will surely be of great importance in the development of required knowledge. That they have been so little used to date and that Arctic research is so dominated by short-range research planning, mostly in response to outer continental shelf oil and gas development, are deficits that have existed for too long. It is clear that scientific and engineering studies on the use of submersibles for long-term research must be conducted as a matter of high priority to help resolve these deficits.

New Klein Sonar Operates at Dual Frequencies Simultaneously

Introduced at Oceanology International '86 in Brighton (U.K.), the Klein side scan sonar operates on frequencies of 100 and 500 kHz. The lower frequency provides relatively long ranges and medium resolution —with a total swath width up to 100 meters. The high frequency, the firm says, otters less coverage (200-meter swath) but very high resolution.

Developed by Klein Associates Inc. of Salem, New Hampshire, the sonar employs digital coded signals—switchable from the surface—to operate the towfish on either frequency or simultaneously on both frequencies. With

Company spokesmen said the sonar opens up new possiblities for side scan sonar operators. The long range scale can be used for target detection, then switched to the higher frequencies for classification—all without pulling in the towfish. *st/*

U.S. EEZ Implementation Needs A Champion!

Soapbox

Michael A. Champ is a professor in the Department of Biology at American University.

March 10, 1986 was the third anniversary of President Reagan's Exclusive Economic Zone (EEZ) proclamation. The proclamation established "sovereign rights" over resources and jurisdiction in an area that encompasses some 3 billion acres, significantly more than the 2.3 billion land acres of this nation and its territories [making the U.S. 1 part land to 1.3 parts seawater]. The National Advisory Committee on Oceans and Atmosphere (NACOA) has heralded "the significance of the EEZ to the future of our country may well be greater than the 1803 Louisiana Purchase." Therefore, it is critical that we periodically review the Nation's progress in implementing the EEZ proclamation.

NACOA in the Fall of 1983 initiated a study to examine the international and domestic implications of independent U.S. action in establishing an EEZ, and highlighted legislative and administrative actions required to implement the EEZ proclamation. The draft reports of this study have become the identification of the elements of a national plan, but have not become the actual blueprints for one as was proposed. This shortfall should have been foreseen from the complexity of implementing the EEZ proclamation. My guess is that such a plan would require active participation of 20-30 people from a wide range of disciplines who would also have extensive experience or knowledge of the legislative mandates and modus operandi of several key federal agencies.

Three years have passed and the federal action has been a series of excellent research cruises and mapping projects but not the implementation of a national plan. This outcome is the result of a lack of overall leadership and not agency program efforts under budget limitations. The EEZ needs a champion. A comprehensive mandate to implement the proclamation is sorely needed.

Currently, the U.S. uses about 52 million tons annually of phosphorite as an inexpensive fertilizer. It has been estimated that the U.S. reserves on land will last about 20 years. However, in the EEZ, on just the Blake Plateau off South Carolina and Georgia over 2 billion tons may be available.

Many of the resources available in the EEZ have been described as either critical or strategic to this nation. Four of these strategic materials (manganese, cobalt, platinum group metals, and chromium) are clearly essential to the U.S., and their uninterrupted suppy is certainly open to question.

These metals are essential in the production of high-temperature alloys, steel and stainless steel, industrial and automotive catalysts, electronics, and other applications that are critical to the U.S. economy and national defense. South African Foreign Minister R.F. (Pik) Botha Bothia even had the gall last summer to tell the U.S. to lay off its equal rights grumbling or he would restrict the export of chromium to the U.S. which would directly affect 300,000 U.S. jobs. The U.S. non-energy mineral trade deficit in 1984 was $19 billion.

High concentrations of cobalt have been found in ferro-manganese nodules; crusts and slabs on the sides of several seamounts in the U.S. EEZ of the central Pacific. It has been estimated that a single seamount (there are over 200 in the EEZ of the Hawaiian Islands) could yield up to 4 million tons of ore, making these deposits far larger than any known source on land. In the 1970s, the U.S. was unchallenged in the field of deep-submergence technology. Since then, France, England, West Germany, Japan, and Canada have passed us in the area of deep-sea mineral exploration. The French brought together highly regarded mining engineers, economists and oceanographers for research cruises to assess the potential of these commercial mineral deposits. The French even acquired the first commercially available SeaBeam seabottom mapping system (developed by the U.S. Navy) from General Instruments in Massachusetts, putting it on their best research vessel three years ahead of the U.S.

The proclamation remains one of the most important and challenging steps taken by a president in the 20th century. President Kennedy's contribution was going to the moon; however, to date and for many future decades, the benefits from space programs have or will come from the travel, associated with either the knowledge gained from or the technology developed for and from the experience. From the ocean, however, knowledge, technology, and resources will be the immediate benefits. Also, many of the resources are renewable resources. The commercial exploration and development of these resources have been very limited because as industry has clearly stated several times, the rules must be identified before the game can be played. Meaning the regulatory structure and authority for the EEZ must be known. It would also tidy up the process if it could be coordinated through a limited number of regulatory agencies or a single body.

There is not space here to discuss the concept of a centralized regulatory structure for the EEZ such as a Regional Ocean Management Authority (ROMA) which could be modeled after the River Basin Commission concept and Fisheries Management Councils. ROMA would also incorporate the concepts of the joint/federal task forces which have received very high marks because they incorporate federal, state and regional interests.

In summary, research and information needs in a wide varity of fields are major hurdles facing exploration and development of EEZ resources. National leadership and a coordinated regulatory structure, however, are the critical weak lines. In their current form our ocean going capabilities have been reduced at a time they should be expanding extensively into R&D of the EEZ.

In the long run, as President Jefferson realized when he went after the Louisiana Purchase, the future was and is resource development. President Reagan's EEZ proclamation was even one better; it not only encouraged the development and utilization of ocean resources but also emphasized conservation and protection of the marine environment.

However, since we can not use the Homestead Act to develop the EEZ, who will remember what Mr. Reagan did? /st/

Scientists claim vast mineral bounty untouched in Exclusive Economic Zone

By Steve LaRue
Staff Writer

It could be considered the Louisiana Purchase of the 1980s — an oceanic territory stretching 200 miles from American coastlines, which is 50 percent larger than the continental U.S. and is brimming with resources.

But modern issues such as budget deficits, low metal prices, and nuclear strategy have prevented large-scale exploitation of the Exclusive Economic Zone three years after President Reagan declared the offshore domain American territory.

"We haven't explored, even in a reconnaissance fashion, enough of the EEZ to know what is there," said Monty A. Hampton, branch chief for Pacific Marine Geology at the U.S. Geological Survey.

This month, the government will publish an atlas of sonar images of the EEZ ocean floor off the West Coast.

Like the 1803 Louisiana Purchase, the President's March 10, 1983, declaration of the EEZ suddenly defined a vast new territory as large as the nation itself and rich with possibilities.

The mineral bonanza includes cobalt, which is used in the manufacture of jet engines; manganese used to produce steel; copper; nickel; phosphorite, which is used to make fertilizers; and more familiar minerals such as platinum, tin and gold.

The U.S. Navy's manned submersible vessel Sea Cliff, for example, discovered saucer-sized nodules, or free-standing pieces, of manganese at a depth of 6,000 feet, about 40 miles west of San Diego.

The discovery is important because manganese is a strategically important metal used to make steel, and also because most such mineral nodules were thought to exist on the ocean floor well beyond the EEZ.

It also illustrates that the new ocean frontier is an institutional one — only corporations and governments have the money to explore it.

Despite the potential mineral riches and industrial and scientific wealth awaiting exploration, little has been done to harvest these underwater resources.

Just the opposite, said Melvin N. A. Peterson, manager of the deep-sea drilling project at UCSD's Scripps Institution of Oceanography.

"The institutions are being informed that they are going to have to cut back on the amount of research time that they have in the oceanographic fleet simply because their budgets are being cut back," Peterson said.

The USGS has canceled one EEZ exploratory drilling program, he said. The National Science Foundation and the Department of Defense also have announced retrenchments in their financing for oceanographic exploration.

"It has been difficult for scientists to try to capitalize on this new area and whip up a lot of enthusiasm for lots more money to work out there," Peterson said.

Additonally, the prices for hard metals such as copper have plummeted in recent years, and strategic minerals like cobalt, used to make the metal for jet engines, can be mined cheaper on land.

"The price of mining in the deep sea is fairly fearsome," Peterson said. "It cannot compete against land-based operations." At least, not yet.

But the potential remains.

Like the United States, Mexico and many Latin American nations have EEZs. In theirs, as in the U.S., foreign mineral exploration is prohibited. Enforcement is monitored by individual countries.

The EEZ of the United States has been estimated at 3.9 billion acres — compared with 2.3 billion acres of related onshore area — and is the world's largest, said Jorge Vargas, a law professor at the University of San Diego.

The reason is that the U.S. EEZ includes areas offshore from many Pacific Islands, like Hawaii, Wake Island, the Northern Marianas Islands and others.

The President's March 1983 proclamation creating the zone is only the second marine proclamation of its type by a U.S. president, Vargas said. He said the first was the Sept. 28, 1945, proclamation by President Harry S. Truman claiming sovereign U.S. rights over the continental shelf, which was vaguely defined as its immediate offshore area.

Navigation is allowed in these waters, meaning that Soviet trawlers can gather electronic intelligence without violating U.S. law in the EEZ but are banned from harvesting fish, probing for oil or sampling other resources without permission, Vargas said.

"This area has been claimed for the United States for all time," Peterson said.

"Like the Louisiana Purchase, I don't think there was any great stampede to go out there. Lewis and Clark were asked to look it over, but they were just two people."

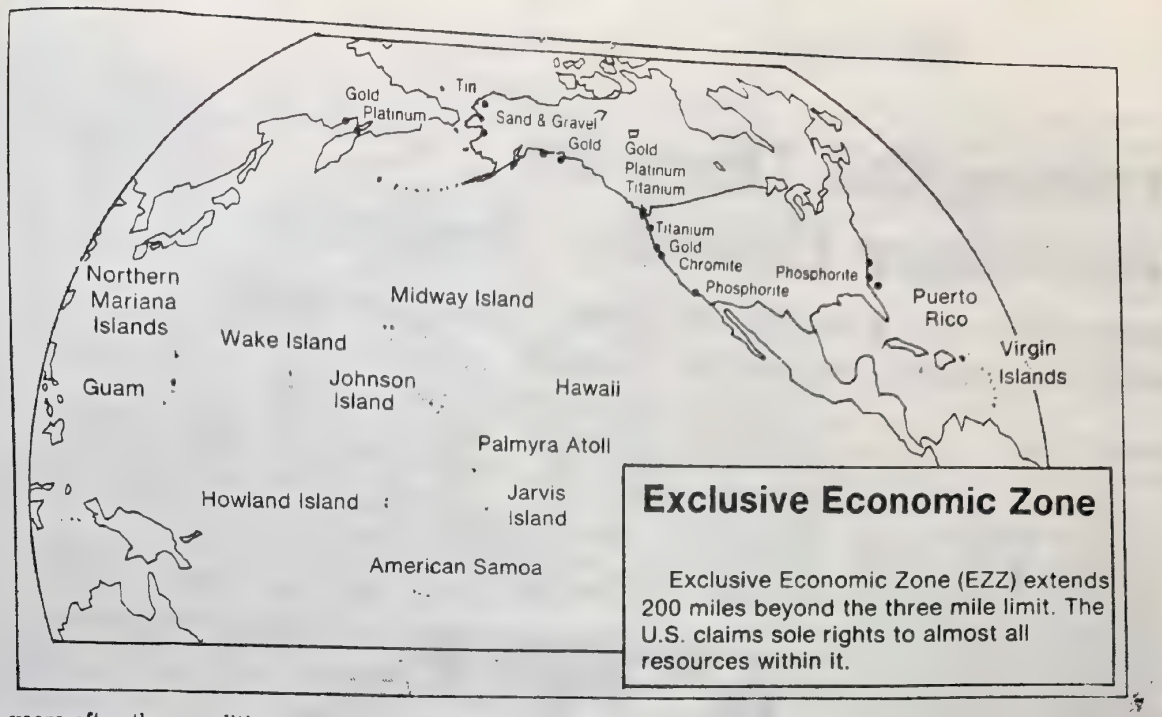
The research vessel Farnella, which called in San Diego in the spring and summer of 1984, is this decade's equivalent of the Lewis and Clark expedition, which mapped the new Louisiana Purchase from 1804 to 1806.

The British-owned Farnella, under a $1.2 million contract with the USGS, used its unique sonar system to map the 250,000 square miles of the EEZ from Mexico to Canada. This began a five-year program to also map the EEZ in the Gulf of Mexico, the Bering Sea and offshore Alaska.

This month, the federal government is publishing an atlas of sound images — looking much like satellite photos of earth — that form maps of the EEZ ocean floor off the West Coast.

The atlas reveals gorges thought to be deeper than the Grand Canyon and peaks that seem to tower higher than Mt. Everest over the ocean floor. And, there are fans of sediment left by currents that also may have sifted out heavy metals into rich underwater mother lodes of gold, chromite, platinum, titanium and tin.

The atlas is expected to spark as much excitement among scientists as Lewis and Clark's first reports of the Columbia or the Yellowstone rivers. The public did not become interested in the Louisiana Territory until



six years after the expedition, when the first accounts were published. Exploitation of the EEZ's resources will wait at least this long, Hampton said.

"We have to know a lot more about the basic science of these things, their occurrence and how they are distributed," he said.

But now scientists and defense planners find themselves asking how much knowledge about the EEZ is too much.

The National Oceanographic and Atmospheric Administration followed in the wake of the Farnella with a high-resolution sonar system that produced sea floor contours so highly detailed that Navy planners say they could be used by Soviet submarines to avoid detection.

"The Navy wants all of that material classified," said Hampton.

"If we can get security clearances, we will get that data," he said. Even if USGS scientists get the required clearances, raw data from this sonar survey of 12,000 square nautical miles of the EEZ may not be available to non-government oceanographers or private exploration companies who want closer looks at suggestive features in the Farnella maps.

Another reason oil companies are not rushing to explore the EEZ is the rapid decline in the world price of oil.

Peterson said that offshore oil exploration has succeeded too well in places like the North Sea, off California's Central Coast, offshore Alaska, off Mexico's coast and elsewhere.

"To a certain extent, this is a reflection of the very great promise of the offshore area," he said.

"The offshore industry right now is in very difficult conditions," he said. "You wouldn't expect to see a very large amount of stampeding into the area (as though it were) a land-grant situation."

Unlike nations that signed the Law of the Sea Convention in 1982, the U.S. does not claim or recognize tuna, a migratory species, as a resource belonging to the country in whose EEZ they occur.

Mexico, among other Latin American countries, claims the right to restrict tuna fishing within their EEZ, and this has led to periodic Mexican seizure of U.S. tuna boats and to the 1980 U.S. boycott of Mexican tuna.

Simrad Claims Higher Resolution For Multi-Beam Echo Sounder

What is said to be a new concept in multi-beam echo sounder systems has been introduced by Simrad Subsea A/S of Horten, Norway. It is claimed that it will set new standards of resolution for seabed mapping.

The new system was developed with support from Statoil and the Norwegian Hydrographic Office. It is designated the EM 100. It is rated for operation in water depths down to 500 meters and a slant range of 550 meters. Its operating frequency is 95 kHz.

The EM 100 features a hullmounted retractable transducer with 96 individual retractable elements mounted on a single compact cylinder segment measuring 40 cm by 80 cm.

Signals from the transducer are electronically beam formed using the company's bitslice technology to form 32 separate beams. These form a 3 degree fan in the vessel's fore and aft plane and a 2 or 2.5 degree fan athwartships, stabilized against ship motion to provide a swath width on the bottom of up to 1.7 times water depth.

These fore and aft athwartship profiles are presented graphically at the operator's console which incorporates self explanatory operation menus and single joystick control.

Measurement values from the EM 100 sounder can be transferred to external data systems for recording or stored on a digital cassette unit of 11.5 bytes M/bytes corresponding to between 5 and 15 hours survey time.

Also available is a realtime contour mapping system for the production of seabed maps with selectable contour intervals down to 0.5 meters at scales of from 1:100 to 1:10,000. Ships course and position data can also be inputted to enable maps to be produced in standard UTM projections for each individual survey line.

Probing the Deep for *Challenger* Disaster Answers

Submersibles Are Key Players In the Navy-Directed Search For Shuttle Debris Off Florida

By David M. Graham
Editor

A massive U.S. Navy National Aeronautics & Space Administration (NASA) effort to recover parts of the ill-fated space shuttle *Challenger* drew a swarm of remotely piloted vehicles and manned submersibles to the search. Some met with varying degrees of success. Some met the cable-tangling Gulf Stream currents and were sent back home.

The crowded waters were reminiscent of the underwater search for a missing hydrogen bomb in 1966 off Palomares, Spain. That memorable operation was an 80-day marathon of recovery efforts when an H-bomb dropped accidentally into the sea from a U.S. Air Force B-52 bomber.

At that time, the cream of the then-new and wonderful submersibles crop was outdone ultimately by a Navy contraption called CURV, for Cabled Underwater Recovery Vehicle.

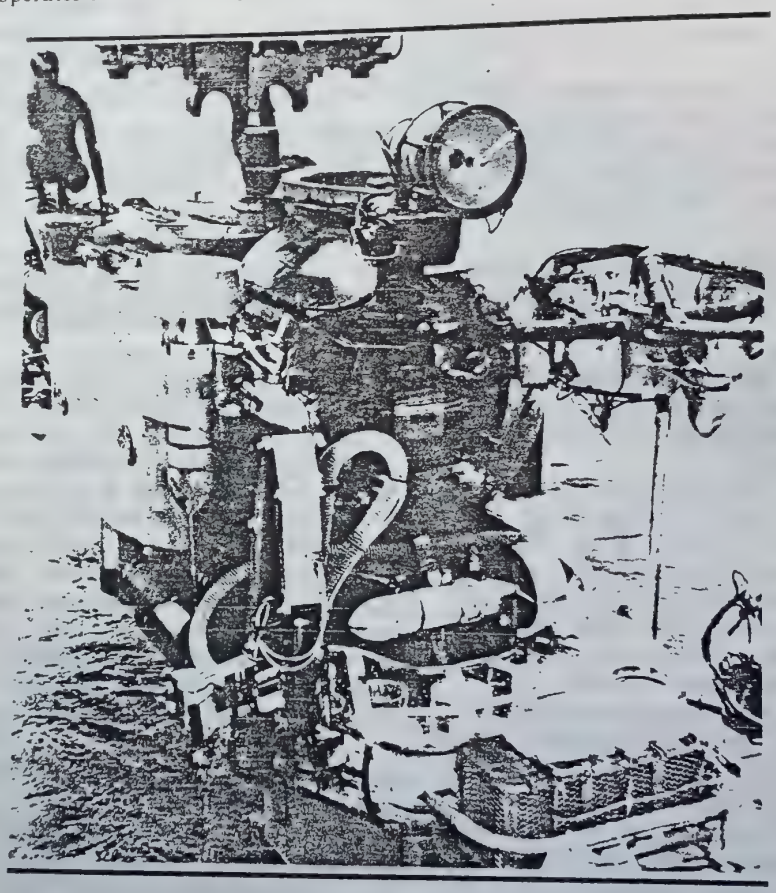
The "H-Bomb Hunt" turned out to be a showcase exercise in those heydays of competing submersibles. This search, on a far more sombre note, has been characterized as closer to a "business as usual" search and recovery mission with a display of the underwater technology the oceanic community now takes for granted.

There have been no high-tech surprises, no broaching the state of the art as in some aspects of the successful *R.M.S. Titanic* search last fall (*Sea Technology*, October 1985, page 70).

Early on, television news watchers following the aftermath of the January 28th disaster above Cape Canaveral saw glimpses of Perry Offshore's new Sprint 101 mini-ROV and Sub Sea Service's Scorpio and Recon IV vehicles as the tide of news shifted to the underwater search for clues to why the disaster happened. The search intensified within days when the Navy and NASA brought in the big guns—Steadfast-Oceaneering Inc. (Falls Church, Virginia) who oversaw the sonar search mission under its contract with the Navy Supervisor of Salvage; Eastport International Inc. (Upper Marlboro, Maryland) who operates ROVs for Navy search and recovery missions, such as the Navy's Deep Drone and Orion vehicles and a borrowed Gemini from Ametek Straza Division; Harbor Branch Foundation Inc.'s (Fort Pierce, Florida) *R/V Seward Johnson* and *Edwin Link* as well as the foundation's four-man submersibles, Johnson-Sea-Link I and II; and the nuclear-powered submersible NR-1.

The bigger vehicles, one source told *Sea Technology*, saved the day because the smaller vehicles were experiencing increasingly tougher sailing in the 5-knot-or-so Gulf Stream currents.

Pressed into service early in the search—partly because of Harbor Branch's proximity to the Cape—the oceanographic research foundation's *Seward Johnson* and the Johnson-Sea-Link II are generally credited with being the first to bring back photographs, video recordings, and some small pieces of debris presumably from the suspect right-hand solid rocket booster.



Harbor Branch submersible Johnson-Sea-Link II was first to bring back color photos, video recordings, and pieces of shuttle wreckage. (NASA photo)

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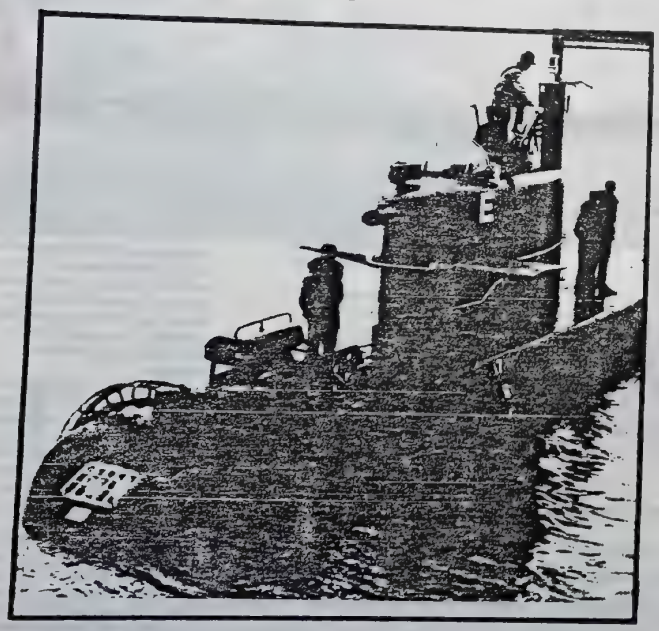
A Harbor Branch spokeswoman told *Sea Technology* a small HBF-built ROV collected several small samples, including a small hydrazine bottle (typically used to power the small steering jets on satellites). The foundation's Cabled Observation & Rescue Device—affectionately called CORD—was designed to work and collect samples in the Gulf Stream's 3-7 knot currents and is tethered to a vessel topside with a less-resistant half-inch armored cable. The larger cables used with the bigger and sometimes underpowered ROVs fell prey to the strong currents, which severely restricted controllability, according to some sources. CORD was followed later by the Johnson-Sea-Link II, which resulted in 35mm still photos and what one observer called "fascinating video" from the vehicle's Marine Optical Systems MOS 1000 and MOS 300 high resolution video cameras.

Visibility at depths apparently is not much of a problem, according to Harbor Branch, because the Johnson-Sea-Link II, at least, sports an HBF-built 7000° K arc light and suite of Birns Oceanographics 1000-watt Snoopers and 360-watt Snooperettes to light the way.

It took several days after the explosion rained debris at sea off Cape Canaveral for an organized effort to get underway. NASA's first order of business then was to retrieve pieces of the *Challenger* and the solid rocket boosters. The U.S. Navy was called in shortly thereafter, which service elbowed out the Coast Guard, whose ships had been gathering floating debris.



The Navy's research submersible NR-1 concentrated her searches in the right-hand booster debris field. (NASA photo)

Coordinating Sonar Sweeps

The Navy then concentrated on a side-scan sonar search to comb the bottom for heavy pieces of the two solid rocket boosters and whatever was left of the crew compartment. At this point as well two civilian firms under contract to the Supervisor of Salvage stepped into the picture. Steadfast-Oceaneering handles worldwide search and recovery of marine objects and, as such, began coordinating the tedious task of conducting sonar sweeps of the entire impact area. Eastport International has a similar contract to conduct undersea operations, working with the Navy's Deep Drone ROV and the towed sonar sled Orion.

In charge overall was the Navy's top salvage officer, Capt. Charles Bartholomew, director of the Ocean Engineering Division of the Naval Sea Systems Command.

Steadfast's Ridge Albaugh told *Sea Technology* his firm organized the search off the Cape using "vessels of convenience." He is one of the firm's project managers.

"We started out with two NASA booster recovery ships, the *Liberty Star* and the *Freedom Star*, and then had to add two more search teams and vessels to cover the 430-square-mile area," Albaugh said. "We chartered two Tracor Marine ships out of Fort Lauderdale (Florida), the *G. W. Pierce II* and the *Paul Langevin III*, which we subsequently dubbed the 'PL3'."

Key to the Steadfast operation, he said, was several Klein Associates' side-scan sonars that essentially were off-the-shelf 100 kHz units used of necessity with a variety of recorders. "We were also operating one 500 kHz fish (also Klein's) on whichever ship was doing sonar target localization and identification," he added. Steadfast personnel began running lines as soon as the search grid was established and all possible contacts were recorded and examined on shore by Steadfast president Mike Kutzleb and independent contractor Bob Kutzleb.

Stena Workhorse, and her 100-ton-capacity crane accomplished recovery of large debris. (Northern Coasters Ltd. photo)

Tying In GPS Positioning

At this point, Steadfast's four Magnavox T-Set Global Positioning System (GPS) receivers came into play. "We tied the sonar contacts into the positioning and then calculated what we call 'trail' or the offset to where the sonar fish should be," Albaugh continued. "For this project, we recommended using Loran-C (for primary positioning) because of the distances offshore and then calibrated and corrected it with the GPS system." He told *Sea Technology* the former were four Simrad Taiyo Loran-C sets.

Parent company Oceaneering International even got into the act by supplying chief surveyor Eric Swinney "to help out by getting all the T-Sets and Loran-C systems hooked together" and to oversee use of Oceaneering's pioneering integrated navigation software program for GPS/Loran offshore oil rig positioning.

On the wetter side of search operations, Navy contractor Eastport International, Marine Systems Division, was barely recovered from its recent long-term project to recover wreckage of the Air India 747 jetliner that was lost in the Irish Sea. Project engineer Michael H. Higgins talked to *Sea Technology* about the vehicles and support vessels the firm marshalled for the *Challenger* search.

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He said the Eastport team used the three ROVs mentioned earlier. "We added the Gemini at the Navy's request because we needed a system that has more capability than, for example, the Deep Drone (and is a) larger, more powerful vehicle to operate in stronger currents." The third vehicle used was Orion, a towed sonar (Klein 100 kHz) sled with still (Photosea) and video (Colmek) cameras aboard. "Eastport didn't use Orion's sonar as much this time because of the shallow depths and strong currents. Orion's more of a very deep system," Higgins said.

Deep Drone, the tethered ROV capable of 1650-meter-depth operations, worked off NASA's *Independence* on reconnaissance sorties, checking out likely sonar "hits."

Gemini: Heavy Worker

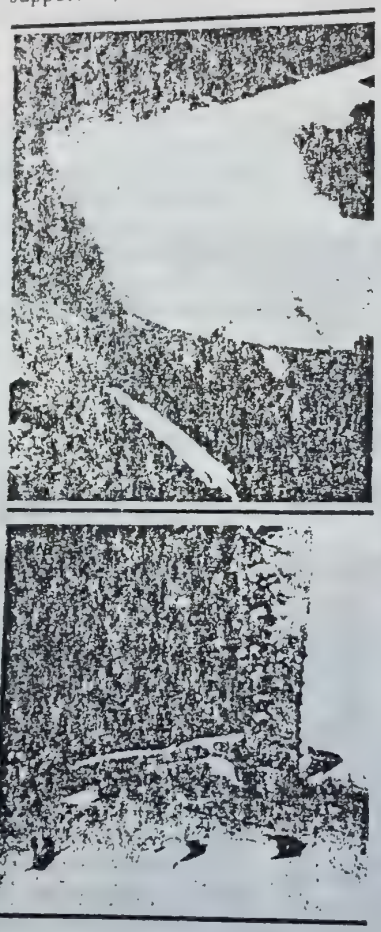
The Gemini, on short-term loan from its manufacturer Ametek Straza Division in El Cajon, California, was working in the same areas as Deep Drone, Higgins added, but was also used for heavier salvage work, such as making attachments to heavier pieces of debris. Gemini's support vessel was the *Stena Workhorse*, a multipurpose offshore maintenance and diving support vessel built and operated by Northern Coasters Ltd. of Aberdeen, Scotland.

Her claim to fame in the *Challenger* search is her 100-ton-capacity revolving deck crane and dynamic positioning features. That was the crane used to lift the burned-through portion of the right-hand solid rocket booster suspected of causing the explosion. *Stena Workhorse* was assisted in that particular recovery by Harbor Branch's Johnson-Sea-Link I—working off the *R/V Edwin Link*—which submersible attached recovery slings and an acoustic marker.

Eastport's Higgins also said Gemini was fitted with two specially designed manipulator arms.

One, according to Canadian builder Robotic Systems International Ltd. (Sidney, British Columbia), is a seven-function spatially correspondent manipulator called Kodiak 1000 that can lift half a ton and reach 1.5 meters. Another, a five-function manipulator "designed and engineered in a matter of days for the *Challenger* recovery" assists by holding the Gemini steady on the ocean floor.

The Navy's salvage operation costs reached nearly $7 million by mid-March, according to news reports. In the early phases of the search, a flotilla of more than a dozen vessels were criss-crossing the target areas. Eight of them were U.S. Navy vessels—including the *U.S.S. Preserver* (ARS-8) whose Navy divers undertook the grim task of recovering the remains of the seven astronauts, and the *U.S.S. Sunbird* (ARS-15), the support ship for the NR-1 submersible.



Photos from Deep Drone ROV show (top) portion of the satellite *Challenger* was to launch, as well as part of left-hand booster lying in 64-meter waters. (NASA photos)

Now that the last critical and "top priority" piece of evidence—the other half of the burned-through rocket booster segment—was recovered April 29, NASA officials have called off the massive 92-day salvage effort. While the shuttle debris search off Florida didn't provide a high-technology showcase, it undoubtedly accomplished much in proving once again the dual concept of effectively using manned as well as unmanned vehicles for performing meaningful work in ocean depths. /stl

Nuclear sub to work on Arctic subsea wells

A support submarine using a power combination of nuclear, stirling and diesel engines will be completed in Canada to service subsea wells under the Arctic ice pack. The prototype vessel's maiden voyage to the North Pole is planned for the 1990-91 time period.

The Saga I, nearing completion in Marseille, France, will be brought to Halifax, Nova Scotia in 1988 for installation of the nuclear power package. It will then become the SSV Saga-N. The submarine is a project of International Submarine Transportation Systems (ISTS) of Halifax, Nova Scotia, which is funding the $120 million vessel. The firm is a joint venture of International Submarine Engineering and Energy Conversion Systems of Canada and Ifremer and Comex of France.

"The Saga-N will be a prototype of what will become the Inuit class of submarines, which will be able to work on deepwater subsea completions," explains J. M. Ewan of ISTS. "We want to eventually design subsea completions and production systems for submarine support and be able to produce from subsea completions without pipelines."

The Saga-N's 100 kW nuclear power plant is a 'Slow Poke' design, developed by the Canadian Atomic Energy Agency for non-attended operation. The reactor will fission 19% enriched uranium. The nuclear power unit will fit in a 40-ft long module which will be inserted in the 140-ft long enlarged Saga I hull.

The Saga-N will have a 60-day submerged endurance capability with a 4,000-mile range. The vessel will be able to support divers with power, heat, compressed gases, and lockout up to a depth of 450 meters, but will be capable of 600-meter depths for ROV support. The Inuit class production model will be capable of depths up to 2,000 meters.

SPRINT AIDS IN CHALLENGER DEBRIS SEARCH

Perry Offshore, at the request of Sonat Subsea Services, provided equipment and crews to aid in the first search for debris following the explosion of space shuttle Challenger. The following is an account of those efforts prepared by Doug Stroud, Perry's Customer Service Manager. Charles Royce and Doug Rutledge of Perry Offshore also contributed.

"Shortly after Challenger exploded on Tuesday (January 28), Joel Kagan of Sonat contacted us to determine if Perry's new SPRINT 101 ROV system would be available for search operations near the Kennedy Space Center. We had just completed a week of testing and preparing the SPRINT for its U.S. debut at the ADC conference in Houston, and we assured Joel that SPRINT was, indeed operational.

Joel offered the SPRINT and an operating crew at no cost to Morton Thiokol, Inc., the solid rocket booster's manufacturer. Morton Thiokol accepted, and within hours Doug Rutledge, our vehicle technician, Charles Royce, our Americas Sales Manager, Jack Champion of Sonat, and I were on our way to Cape Canaveral.

On arrival we mobilized SPRINT aboard the M/V Liberty Star for Morton Thiokol. The SPRINT was the first production unit in the U.S. from Robertson Tritech in Norway. So, in essence, this was the first sea trial for this particular vehicle.

On the 29th we launched on a suspected sonar target in 140 FSW, but found that we weren't able to stay on the bottom (we thought because of current). Surface current was around 1-¾ to 2 knots. We were taking this into account when diving and driving against the current, full stick forward while descending.

The surprising power of the four axial thrusters on the SPRINT actually confused us, initially. We were flying out of tether forward before reaching bottom.

We found subsea currents less than one knot and the SPRINT handled this easily. Once we began diving straight down with no axial commands, we had no difficulty reaching bottom. Once on bottom, we began searching approximately North-South, East/West grid patterns around suspected sites.

By punching in Auto Heading and Auto Depth, the SPRINT ran straight grid patterns and held depth easily within two to six inches.

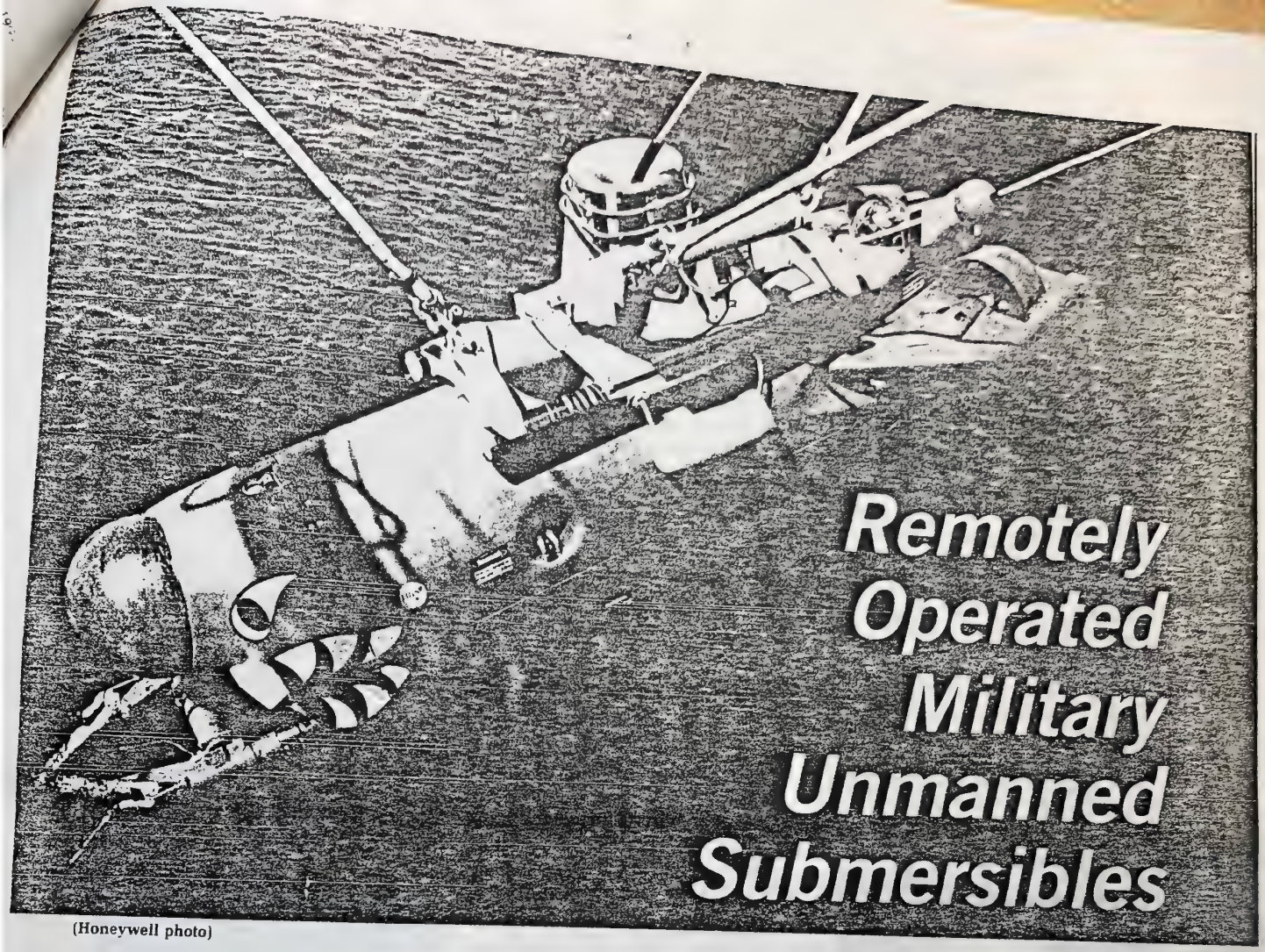
Visibility was around seven feet and we stayed about two feet off bottom, using the SIT camera for navigation and the color video camera for closeup work. Although we found no debris, we covered large areas rapidly and eliminated sections of the search area as possible sites of Challenger wreckage.

After several areas were searched we returned to NASA base where Mark Bolas of Bentex arrived from San Diego with backup spare parts. But, in spite of an inexperienced crew and some difficult operating conditions, we replaced only one thruster and one strobe tube during the entire operation.

The 30th was spent searching for surface debris. About 1730 hours we were called back to dive on a new sonar target. With the vessel anchored we were able to run out 750 feet in all compass directions. With 750 feet of tether out, we had no trouble with tether drag, and SPRINT was able to run the grid patterns with no difficulty at all. Thrust was more than powerful enough to do everything required of the vehicle.

By Friday, the search was moving into water depths of 1200 FSW. Since we had only 1,000 feet of tether, it was decided we would off load and other vehicles would take up the search. Sonat later brought in a Scorpio and two Recon IV S's to continue the search.

We feel this was a successful sea trial for the new SRINT 101, and although the circumstances were tragic we gained a great deal of useful operating knowledge and confidence in the vehicle system.



Remotely Operated Military Unmanned Submersibles

(Honeywell photo)

Steven M. Shaker

For military undersea emergencies, the combination of extreme hazard and the frailty of the human animal, say in finding and recovering a nuclear bomb damaged in a midair collision, are spurring the increased development and use of improved robotic underwater vehicles.

These unmanned submersibles, commonly referred to as remotely operated vehicles or ROV's, are more and more taking over dangerous missions that could entrap or disable manned vehicles or divers. If the ROV is destroyed, the loss is replaceable machinery and not irreplaceable lives.

The option of using underwater robots allows a mission commander to be more selective; he can reserve higher-priority missions, or those requiring intricate on-the-spot manipulation, for accomplishment by skilled personnel in manned submersibles. Budget constraints and shortages of skilled manpower have meanwhile furthered the use of ROV's. Eliminating expensive and bulky life-support systems tends to make them cheaper and smaller than manned submersibles. With none of the limits imposed by dive times and staged-ascent decompression times imperative when unpressurized systems for human divers are used, ROV operations can also be more efficient and less time-consuming.

Danger: Lost Nuclear Bomb

The first U. S. Navy ROV's were introduced in the late 1950's, and were used for underwater inspections, survey location, search and identification tasks, and retrieval of objects on the bottom. In 1966, the Navy Cable Controlled Underwater Recovery Vehicle, CURV-I, starred in an adventure as suspense-filled as any best-selling novel.

In mid-January 1966, off the Coast of Spain, a SAC B–52 collided with a tanker plane while at-

tempting to refuel. The wreckage of the aircraft and its deadly payload were scattered both over land and water. While the free world held its breath, four of the five 20-megaton hydrogen bombs, which had fallen harmlessly on land, were recovered in the ensuing days. But where was the fifth?

Rumors flew. Some said the bomb was ticking and might explode any minute, wiping out a good-sized portion of the Spanish Riviera. Others whispered of a James Bond-like scenario, saying that Russian agents in skindiver suits had made off with the missing bomb. Still others agreed that frogmen had hijacked the nuclear bomb, but said they were international terrorists.

After profuse diplomatic apologies were made to Spain, a manned U. S. Navy submersible, the ALVIN, searched for weeks. Finally, it located the missing bomb, which lay half buried in 2,850 feet of water. To the immense relief of those who believed them, the ALVIN's crew reported that the bomb appeared to be intact. They rated the chances of its detonation as nonexistent and the danger of radioactive leakage as remote.

The bomb, the ALVIN crew reported, lay enmeshed in a tangled web of the shroud lines from its own parachute. The danger of a last-minute catastrophe, if the submersible became entangled in the chute shrouds, was considered unacceptably high. Instead, the Navy then sent in CURV-I.

Working at a sluggish pace, CURV-I managed to attach the first lift line to the deadly bomb. It then hooked on the second lift line. When CURV-I attempted to attach the third and last lift line, what might have happened to the ALVIN and its crew was graphically demonstrated. CURV-I was trapped, inextricably entangled in the parachute shrouds.

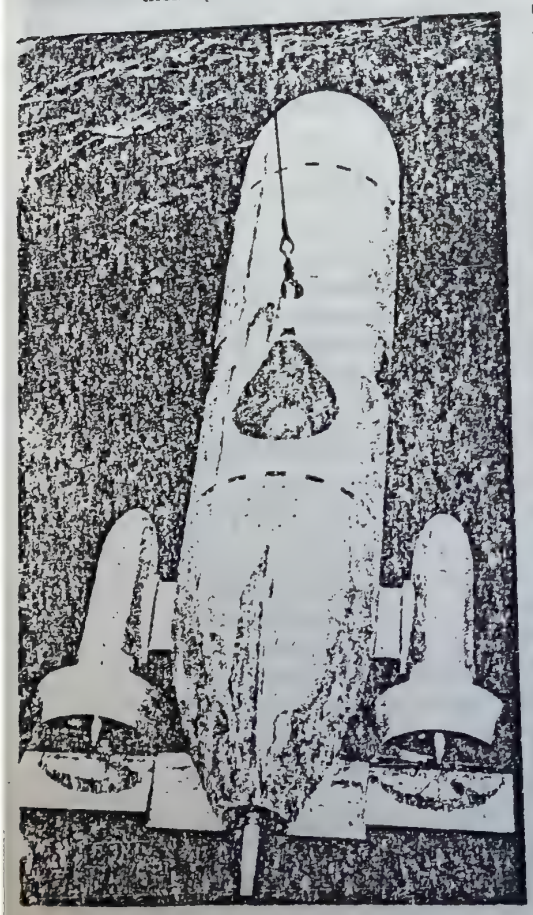
Nevertheless, the remotely operated vehicle had the bomb. Like two great metal fish trapped in a net, the two entwined together were gingerly hauled safely to the surface.

Recovering the bomb, however, did not dispel the rumors of radioactive pollution which killed Spain's tourist trade around the resort of Palomares for three long months. U. S. Ambassador Angier Biddle Duke fixed that. In swimming trunks, the American Ambassador himself plunged into the warm clear waters at the popular beach, and news photos and television footage showed him standing waist deep in the gentle surf, beaming. The inspired Spanish nature of this gesture left the country's government and people no choice but to cheer, "Ole, Embajador!" and pronounce Palomares safe once again.

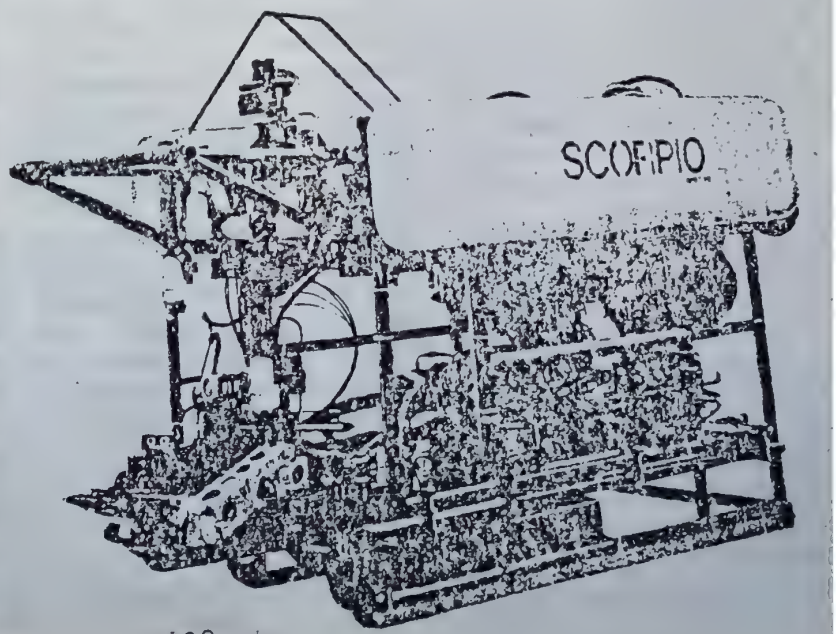
More ROV's

Following the acclaim received by the CURV-I, the U. S. Navy constructed and funded contractor development of eight additional tethered ROV's. These included several modified versions of the original CURV. The CURV-I weighed about 3,000 pounds, had a length of 15 feet, could reach a depth of 2,500 feet and carried 2 cameras, sonar and a manipulator. By the time CURV-III was developed, the vehicle had grown to

The remotely controlled PINGUIN B3 mine disposal vehicle destroys mines by setting off explosive charges near them. (MBB photo)



The Scorpio subsea work system has figured heavily in the CHALLENGER space shuttle recovery operation. (Ametek Straza photo)



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Robots Lead Challenger Recovery Effort

In an effort resembling paleontologists reconstructing a dinosaur, the investigators of the January 28, 1986, *Challenger* Space Shuttle explosion are putting together the pieces of the wreckage in order to better understand its cause. Robot submersibles have played a vital role in sifting through the fossilized remains of the myriad of rockets launched over Cape Canaveral during the last three decades, and the shipwrecks dating back to the time of the Conquistadores, to find the *Challenger* debris.

A recovery force of some 17 Navy and Coast Guard ships and numerous Coast Guard, Navy, and Air Force patrol aircraft and helicopters spent the first few days sweeping across 6,000 square miles of the ocean surface, gathering the evidence. The search quickly shifted to the ocean floor posing numerous difficulties for the recovery team. Although surface vessels obtained sonar contacts suggesting possible shuttle pieces, bad weather and the extreme depths, sometimes exceeding 1,000 feet where much of the debris was located, prevented standard diving operations. Salvage of some pieces such as the satellite rocket was considered extremely dangerous to divers and manned vehicles because its fuel could be ignited underwater by a stray spark. Three robot submersibles operated by private underwater service and salvage firms were deployed to the scene.

The tiny Recon 4 and the 240–pound Sprint unmanned submersible which is built by Perry Offshore Company of Riviera Beach, Florida, provided camera coverage to determine what the wreckage "pinged" by the sonar actually was. They provided the first glimpse of part of the *Challenger*'s crew cabin.

A larger, 2,500–pound remotely operated vehicle (ROV) named the Scorpio utilized its two manipulators to actually grab some of the shuttle pieces and return them to the surface. One manipulator is a five-function arm controlled by a joystick resembling that of an arcade game. The other seven-function arm is controlled by a "master-slave" system. This is where a smaller, replica arm called the master is located in the support ship's control room. In moving the master arm to the desired position a computer in turn measures the new coordinates and transmits the corresponding control signals through a cable to Scorpio's slave arm. The manipulators are electrohydraulic, requiring up to 27 gallons of hydraulic fluid per minute.

Engineers familiar with the salvaging of parts of the Air-India Boeing 747 in over depths of 6,000 feet of water were consulted about their use of an unmanned submersible. They had located and retrieved one of the aircraft's flight recorders with the underwater robot.

Robot vehicles helped "pave" the way for follow-up searches by identifying the best objects for additional inquiry. Manned vehicles such as the Johnson Sea Link II research submersible and the Navy's NR–1 nuclear powered, deep-water research and engineering submarine joined in on the search effort several weeks later and provided in-depth investigation in the areas pioneered by the ROV's.

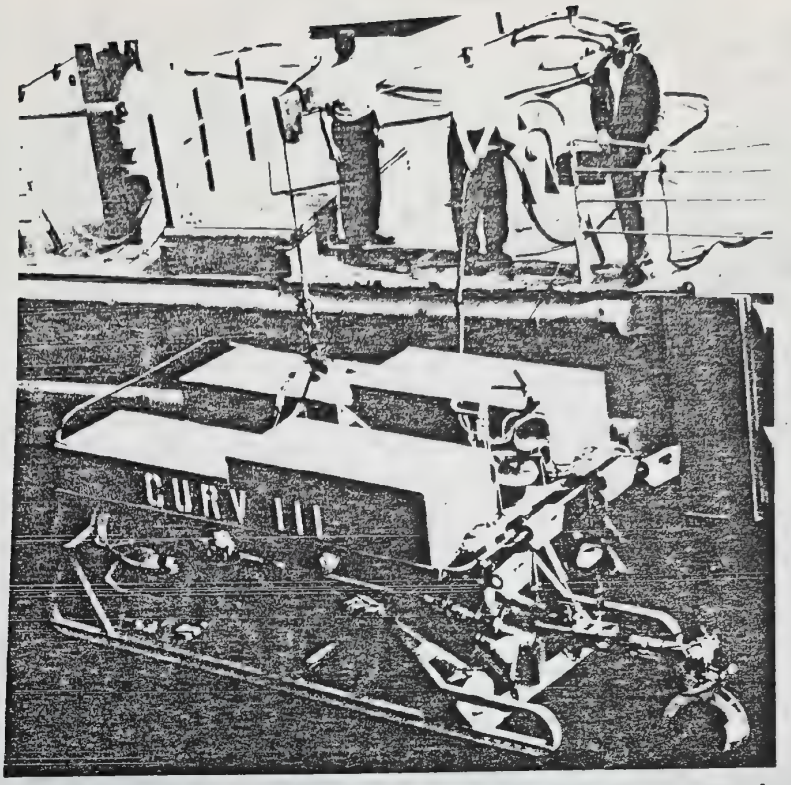
4,500 pounds due to the replacement of the manipulator with a much larger, more sophisticated robotic arm. Looking like an overstuffed lobster, this increased bulk slowed down the underwater craft from 3 to 2 knots.

The cable for the tethered type ROV's served as the submersible's "lifeline" providing it with an unlimited energy supply, a high transmission rate capacity, and a safety link to the support ship. The follow-on ROV's to the CURV-I also participated in some spectacular recovery missions, though in those cases it was human lives rather than nuclear weapons which were saved.

In June 1973, the manned Johnson-Sea-Link (J-S-L) mini-sub was exploring the burned out hulk of a scuttled World War II destroyer off the coast of Florida. While darting in and out of the destroyer's rigging, the J-S-L became snared. Divers tried frantically to free the manned mini-sub, but the strong currents which existed at this 360 foot depth hindered their efforts. Another manned submersible was sent to rescue the J-S-L, but as luck would have it, this manned vehicle experienced an equipment malfunction causing it to abort the mission. In a last-ditch effort, an ROV used by the Naval Ordnance Laboratory at Fort Lauderdale to inspect underwater hardware was equipped with a danforth anchor. Operators located aboard the research vessel, A.B. Wood II, expertly maneuvered the robot sub into hooking the J-S-L, and after 32 hours, the manned mini-sub was pulled free from the sunken destroyer.

PISCES Rescue Operation

Just two months later, a Vickers Oceanics Ltd. PISCES II manned submersible had its aft machinery sphere hatch cover torn off while retrieving some equipment. The sphere quickly flooded, and sank stern-first to 1,575 feet, 159 nautical miles southwest of Cork, Ireland. The two occupants were estimated to have less than 78 hours before their vessel's life support functions failed. As the precious minutes ticked by, an international rescue effort consisting of British and U. S. Naval elements as well as several underwater salvage companies, was organized. The PISCES III sister vessel, PISCES V, attached a toggle hook carrying a four-inch polypropylene line to the sunken submersible's padeye but it fell out. The



The CURV-III, follow-on vehicle to the CURV-I which successfully rescued a nuclear weapon in a spectacular operation off Spain in the 1960s, is shown being lowered in an undersea test. Another CURV-III was used in a successful undersea rescue operation of the British submersible PISCES in 1973. (U.S. Navy photo)

several moments of despair quickly dissipated when the anchor on its own managed to snare the port motor guard. A third "sister" submersible PISCES II managed to hook a 3–1/2 inch polypropyleme line to PISCES III's machinery sphere. The U. S. Navy's CURV-III ROV was airlifted by the Military Airlift Command all the way from San Diego, California, to Cork. The CURV-III was then loaded aboard the JOHN CABOT, a Canadian cable laying vessel under contract to the U. S. Navy, and transported to the rescue area. A third essential line made of 6–inch braided nylon was attached to the machinery sphere by the CURV-III, enabling the PISCES III and its submariners to be safely pulled to the surface with only 1 hour and 43 minutes of life support remaining.

A crash of a U. S. Navy A–7 aircraft occurred in March 1977 off the coast of Japan. For some unknown reason, the aviator was unable to separate from his ejection seat and deploy his parachute. He drowned still strapped in his seat. After many hours of search, the Navy's ROV Deep Drone was able to locate and attach a grapnel to the seat. The support ship pulled the ejection seat and the aviator's body to the surface. The Navy thereby obtained the evidence to provide clues as to what went wrong, and provided a proper burial for the officer.

U.S Navy ROV's have performed other important missions besides retrieving H-bombs, hardware, and people. Prior to our ecological consciousness, containerized radioactive wastes and chemical warfare munitions were frequently dumped in ocean areas. One such area, approximately 30 miles offshore, received these dangerous agents from 1946 until 1959. Concern over their status in 1974 led the Office of Radiation Programs of the Environmental Protection Agency to request the Navy's assistance in surveying the area and the condition of the containers. This task could have been extremely hazardous to divers of manned submersibles if the area were heavily contaminated. The CURV-III scrutinized the site, operating at depths of over 3,000 feet, for a five day period. During its diving time of 32 hours, the ROV took hundreds of color photos of the area, and grabbed numerous sediment cores and container samples.

The CURV-III proved instrumental in overhauling the U. S. Navy's strategically valuable Azores Fixed Acoustic Range (AFAR). Its duties included: rigging an acoustic tower so it could be lifted from the sea floor, cutting electric cables and retrieving them, mapping with sonar the acoustic tower sites, and inspection of the range once all other work had been completed.

The U. S. Navy has an Unmanned Vehicles Detachment which operates out of the Submarine Rescue Unit at NAS North Island, California. This group of elite people and robots conducts search, location, rescue, and recovery operations throughout the world.

Tactical ROV Use

The mid–1970s saw the first usage of ROV's in the tactical arena, primarily for mine destruction missions. These ROV's were equipped with television or sonar heads, and carried an explosive charge to detonate the mine, or cutters to slice the mine's anchoring line, thus floating it to the surface for detonation. The British used the French Societe ECA built PAP 104 to carry out thousands of mission runs during the War in the Falklands. During the summer 1984 mine clearing operation in the Red Sea, the Royal Navy's

Swedish-built SUTEC Sea Own ROV succeeded in locating and recovering a Soviet mine never seen before. The Italian SMIN consortium has built four of their MIN (mine identification and neutralization) ROV's for the Italian Navy for use onboard the new "Leric" class mine hunters. The West German MBB PINGUIN B3, SUTEC's Sea Eagle, and the British Trailblazer mine disposal vehicle built by Fairey Systems have also joined the ranks of West European navies.

Not to be outdone by the Europeans, the U. S. Naval Sea Systems Command awarded a $30.1 million contract in 1984 to Honeywell's Marine Systems Division for the production of a number of highly sophisticated mine neutralization systems (MNS). The MNS utilizes an ROV (equipped with a high resolution scanning sonar and television system) to find, classify, and neutralize underwater bottom and moored mines. Honeywell had begun development of the MNS in 1978 and much of the original design and testing occurred at the Naval Ocean Systems Center, San Diego. The ROV itself is manufactured by Hydro Products, a division of Honeywell's wholly-owned subsidiary, Tetra Tech.

Tether-Free ROV

Since the mid–1960's, the U. S. Navy has had the goal of producing a tether-free ROV, one which could be dropped in the water, perform its mission, and return to the support vessel without direct human involvement. The electromechanical umbilical cable is a "double-edged sword" in that while it provides an unlimited energy supply, high data transmission rate capacity and safety link, it also restricts maneuverability, accessibility, and often requires extensive maintenance and replacement.

There are two separate design thrusts pacing tether-free ROV research. The first is to develop techniques for transmitting information and control signals at a high data rate between the support ship and ROV. These include ways to quicken the transmittal rate of acoustic telemetry, and techniques of sending real-time video. The other approach is to fully develop autonomous underwater robots which have the artificial intelligence and sensors enabling the ROV to sense its environment and make decisions as to the correct course of action.

One such "smart" ROV is the Control System Test Vehicle (CSTV), built by the Naval Coastal Systems Center in Panama City, Florida. This 30 foot scale model of an actual operational fleet submarine was designed to determine the control characteristics faced by submarines under certain transient conditions. The CSTV is equipped with a computer to collect data on its dynamic motion and to guide and control the ROV. It also has a low data rate digital acoustic position and telemetering system.

Research on a robot submarine designed for warfare in the 21st century is being conducted by the Marine Systems Engineering Laboratory of the University of New Hampshire in conjunction with Shenandoah Systems Company of Vienna, Virginia. This vehicle, known as the Long-Range Autonomous Submersible (LRAS), is conceived as a high-payload vessel ranging from 65 to 85 feet long and 13 to 15 feet in diameter. It could deliver a payload of 50 tons up to a distance of 10,000 nautical miles.

In the surveillance mission profile the LRAS would monitor traffic at strategic choke points with its TACTASS array. It also could analyze intercepted radar and communications data. The LRAS would be ideal for the covert reconnaissance of heavily defended areas where extensive mining is expected, or locations inaccessible to manned submarines.

AW6 86

The LRAS can also be used to probe enemy anti-submarine and surface forces to guage their capabilities without risking a manned submarine. It can emit false signatures to elicit and monitor the enemy's response. This sophisticated ROV could also go on the offensive by laying mines and launching torpedoes or missiles at whatever target it has been preprogrammed to attack. Enemy vessel acoustic signatures or other non-acoustic identifiers could be used to set the LRAS into its attack mode and upon receiving further input, trigger its weapon systems.

The British company Scicon Ltd. recently revealed their concept for a robotic submarine to meet the naval needs of the next century. The Scicon Patrolling Underwater Robot (SPUR) design is for a 36 foot long vehicle which weighs 50 tons and is capable of diving to depths in excess of 19,266 feet. Plans for the SPUR incorporate artificial intelligence architecture allowing it to operate autonomously at sea for two month patrols. Tactical weapons include its own torpedoes as well as an internal warhead that explodes the remaining onboard fuel for suicide attacks. It will also be able to put wire around propellers for the covert impairment of enemy vessels.

ROV missions have recently expanded from search, retrieval, and rescue tasks to performing mine location and destruction. The merit of building autonomous weapon systems is becoming more and more evident with the advancements in artificial intelligence architecture, robotics, underwater acoustic telemetry, and other related technologies. "Killer Robots" will significantly affect tomorrow's naval warfare by conducting their own patrols and attacking with their own novel weapons. Not only will underwater warfare become more lethal, but the survivability of manned systems will be in question. ■

SUBS FOR SALE

SUBMARK has taken on an agency agreement with BUE to sell their remaining submersibles. Diver lock-out subs available are Perry's L1 (ex PC15), PC 1202, PC 1801 and the Slingsby L4. Observation subs are Slingsby's T1, L2 and L3, as well as Pisces 3, 8 and 10. The Perry PC 1601 is available as an observation/dry transfer sub. Contact them for full details and prices.

Sub Duels Under Polar Ice: How Ready Is U.S.?

As the Soviets change the rules of the game, the American Navy is scrambling to keep its advantage.

The U.S. Navy is gearing up for a new kind of warfare—swirling submarine dogfights under the polar ice.

It is a kind of combat for which American submarines, weapons and tactics are ill-suited, and the Navy is scrambling to meet the new challenge.

Forcing the change in strategy is the Russians' gradual shift of the bulk of their submarine-launched ballistic missiles from the Atlantic and Pacific to a "bastion" close to the Soviet homeland and beneath the Arctic Ocean.

Critics charge that the Navy has been agonizingly slow to recognize and adapt to the shift. "This is not a surprise, but we just didn't focus on it," a top Navy intelligence officer admits.

Specialized vessels. Both the United States and the Soviet Union have two basically different kinds of submarines. Some are attack boats designed to take on surface ships and other subs with torpedoes and cruise missiles. The Americans have 91 nuclear attack subs and five diesels, a total of 96. The Russians have 112 nuclear attack subs and 168 diesels for a total of 280.

The other class of submarines consists of very large boats carrying ballistic missiles that can fly thousands of miles. The Soviets have 62 of these, compared with 34 for the U.S.

If, at some stage in a war, the Navy were ordered to try to destroy the big subs carrying the Soviets' strategic reserve of nuclear missiles, the ensuing combat in the inhospitable northern seas would be unlike anything that the world has ever seen. Except for a couple of accidental encounters during World War II, there have never been any submarine duels.

A confrontation among submarines would be more like aerial combat than the stealthy, slow-moving submarine maneuvers of the past. American vessels would become the quarry of fast, deep-diving Soviet subs as well as of aircraft and surface ships.

Submarines on both sides would twist, turn and dive—firing torpedoes and dodging them. Some boats might travel 50 miles per hour, and the sea would be filled with the sound of violently thrashing subs, noisemaking decoys and high-speed torpedoes.

The battling would take place in an eerie world. In the zone surrounding the permanent polar icecap, immense blocks of ice grind against one another, filling hydrophones with what sounds like millions of ice cubes rattling in a huge glass.

Even now, American submarine personnel are training in these waters below the ice, potential battle zones of the future. Crews must be on constant lookout for icebergs, some a thousand feet deep and several miles across.

In winter, there is often little maneuvering room between the ice and the sea bottom. Adm. James Watkins, chief of naval operations and himself a submariner, says that skippers constantly ask themselves: "Am I moving into the valley of death by entering a canyon I can't get out of?"

As submarines glide beneath the polar ice floes, they enter yet a different undersea world where the waters may be 3 miles deep and the ice 30 or 40 feet thick.

The sound of the ice is more muted, mixed with the weird noises of marine life. Sound waves bounce around in confusing patterns. Instead of icebergs, huge "keels" of ice extend as deep as 900 feet.

Danger is everywhere—and it is here that the Soviets are believed to have chosen to hide their new *Typhoon*, the world's biggest sub, armed with 20 nuclear missiles and designed specifically to break through the ice and fire its missiles.

But even a vessel as huge as the *Typhoon* cannot crunch through the full thickness of Arctic ice. Instead, it seeks spots known by their Russian-origin name, polynya, where the ice has melted. Hiding inside these cavities, it would be hard to find with sonar and almost impossible to torpedo. The Soviets are believed to be building more subs of this class.

The bastion strategy now seen as a major test for the U.S. Navy is, ironically, a tribute to American successes in antisubmarine warfare. While quiet U.S. missile-launching boats are able to hide successfully in the vastness of the world's oceans, their noisier Russian counterparts can't move far without being detected.

As a result, the Soviets have spent billions of rubles to develop missiles powerful enough to hit targets in the U.S. from home waters and huge *Delta* and *Typhoon*-class subs to carry them.

Tit for tat? In recent weeks, the Soviets have sent a string of several *Delta* subs into the Atlantic. But Navy Secretary John Lehman sees this as strictly a political response to the deployment of American missiles in Europe.

"They have reduced our warning by an insignificant amount. They have increased their vulnerability by a significant amount. We would invite them to deploy all their *Deltas*" in the Atlantic, Lehman says.

The big difficulty facing the U.S. attack-submarine force is to deal with the Russian subs in the frigid waters close to their homeland—a task quite different from the role for which the American force was designed.

The big *Los Angeles*-class attack submarines—the most modern in the Navy—were specifically designed to operate with fast carrier task forces in the deep, open oceans. Now, they are being asked to go alone into the shallow waters near the Soviet homeland and under the thick polar ice.

In the early stages of the battle, the skippers will have friendly air and surface support. Chains of undersea listen-

ing devices, known as SOSUS, as well as surface ships trailing long arrays of hydrophones, will tell them where to look for hostile subs.

But as they go farther north, they will find themselves on their own.

Vice Adm. Nils Thunman, deputy chief of naval operations for submarine warfare, says U.S. subs must be prepared to "penetrate deeply into hostile seas to conduct sustained independent operations."

This means that the vessels will be expected to operate in the big, deep Norwegian Sea as well as in the shallower Barents and Kara seas, north of Murmansk; the Sea of Okhotsk, off the Soviet east coast near Japan, and beneath the polar ice.

It also means special problems for the American boats.

The U.S. strategy is to send submarines out alone. They rely on quietness and supersensitive detectors to find the enemy first and maneuver into position for the first shot. Instead of the loud pings familiar to viewers of World War II movies, the Americans rely primarily on passive sonar, which listens without emitting any sound.

The American subs carry delicate antennas and superpowerful computers that pick up all the noises of the sea, from the chatter of dolphins to the roar of high-speed commercial ships, and then sort out the sounds peculiar to submarines.

Telltale rhythm. They listen especially for sounds given off by pumps and motors. Such low-frequency sound may be no more than a gentle murmur, yet it travels long distances. The sound pattern is so distinctive that it is possible both to tell that it is coming from a submarine and to identify the class of sub.

It may take an hour or more of cautious stalking before the American skipper is prepared to shoot. Then the torpedo speeds out, trailing a wire that guides it. When its own sensors take over, the torpedo accelerates to 60 mph and lunges toward the target.

The weapon is noisy—"the world's quietest submarine and the world's noisiest torpedo," one critic complains.

The crew of the target ship has a maximum of 12 minutes to fire its own torpedoes, even if a hit can't be avoided. Having given away its presence, the U.S. sub next must avoid the Russian torpedo. What's worse, the American crew, trained to fight one on one, probably will find itself outnumbered and locked in an ambush.

Although the Soviet subs don't match the American vessels in overall quality, there are many more of them.

"The Soviets will come out of the Kola [bases on the Kola Peninsula] three or four at a time. Our submarine people don't want to think about that," says William Ruhe, a World War II submariner who edits the *Submarine Review* of the Naval Submarine League.

"My concern," says one active-duty officer, "is their ability to string numbers of subs together in mobile mine fields and wait for us to come to them. That is very disconcerting."

Richard Pariseau, a naval analyst writing in the *Proceedings* of the U.S. Naval Institute, predicts a "frightening melee" in which subs would be "launching weapons with near reckless abandon."

The U.S. boat may find itself contending not only with Russia's tiny new titanium-hulled *Alfa*, the world's fastest, deepest-diving sub, but also with diesel boats quieter than itself.

Another problem is that American subs have only four torpedo tubes, compared with six or more on Soviet boats—a potentially lethal disadvantage in an undersea dogfight.

The torpedoes themselves, of which the United States has far too few, do not perform well in shallow water or below ice. But sub skippers say they worry most about the relatively few torpedoes they carry—actually fewer than World War II boats.

In the *Naval War College Review*, Hamlin Caldwell, a Washington-based analyst, paraphrases Muhammad Ali: "Our attack submarines float like a butterfly and sting like a butterfly."

Moreover, American boats are not designed to operate efficiently under the ice or in the shallow waters where Soviet missile subs hide.

Thin skins. American boats have a single-hull design, which helps to make them both quiet and fast. The Russians, who are willing to sacrifice quietness for ruggedness, use a double-hull design. In a slugfest, a Soviet vessel may be able to take the first blow and keep on fighting, while the American sub is doomed if more than one of its compartments is ruptured.

U.S. sub crews are training intensively for under-ice work. They are inventing new tactics and experimenting with the settings on their torpedoes to make them more useful in shallow-water and under-ice encounters.

The Navy is also adapting existing subs for work beneath the ice, modifying the Mark 48 torpedo and developing a superb new sonar. In the future, it hopes to add 30 new billion-dollar subs to the fleet.

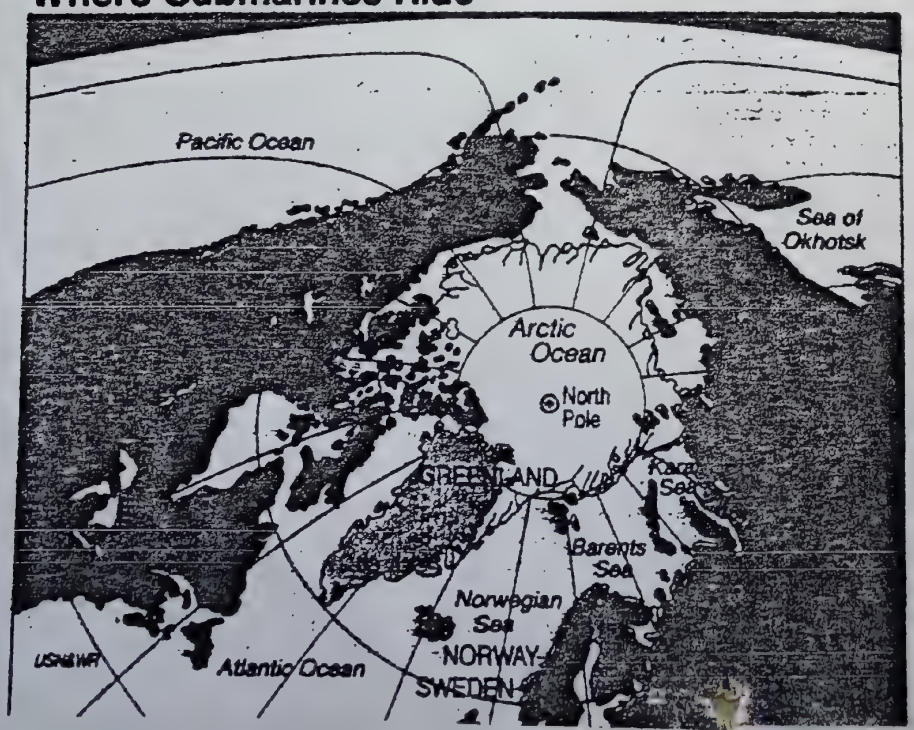
With this modernization program, plus the clear superiority of American sub crews, say top Navy officials, the U.S. will retain a relatively narrow lead in quality over the Soviets.

Yet critics worry that even the program under way will not be sufficient to make the U.S. submariners sure winners in a subsea contest.

The Russians, they note, in addition to having three times as many subs as the U.S., are building 8 to 12 new attack subs each year, compared with 4 for the U.S.

And the Soviets seem pleased with their bastion strategy. Says one analyst: "I think the Russians are confident that if we come up there, they will wind our clock for us." □

Where Submarines Hide



DEEP SUBMERSIBLE PILOTS ASSOCIATION

NEWSLETTER

NOVEMBER, 1986

Vol. XIX, No. 3, Published by the Deep Submersible Pilots Ass'n

The DSPA was formed in 1967 to provide for a free interchange of information relative to manned submersible design, operations, techniques, and materials in order to further the safe and peaceful progress of man into the deep oceans.

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EDITORIAL NOTES AND COMMENTS

It is a pleasure to announce a rousing "Welcome On Board" to new Members: LCdr Alvin Cerveny- ex-AVALON, Dudley Foster- ALVIN, Terrence Owens- SEA CLIFF, William Pigg- AVALON, Pat Raetzman- ex-MYSTIC, David Sanderson- SEA CLIFF/TURTLE, and Juergen Schauer-GEO; new Associate Members:Jon Engstrom- ex-DOWB, David McCafferty- ex-TRANQUEST/DEEP QUEST, Andrew Rechnitzer- ex-TRIESTE; and new Corporate MemberThomas Taylor- Taylor Commercial Submarines of Toledo, Ohio.

Address verification forms distributed with the August NEWSLETTER are still trickling back to me. Many thanks to the 50% of Members who responded promptly and an urgent plea to the laggards for an early submission. We would like to publish an address list to all Members as soon as possible.. Lists will not be sent to non-responders.

Greatly appreciated news contributions were received from Vance Bradley, Pat Smale, Craig DeWeese, Ralph Hollis, and Rich Slater. Please remember that your friends in DSPA would like to hear about your activities even though they may be presently far removed from submersibles. Also, your regular reading may include items of interest that the rest of us have missed. Send me your clippings.

Members are encouraged to use the NEWSLETTER to spread the word. If you know of a job opening, if you are available for hire, if you want to advertise your services, if you want to brag about your successes or sing the blues about problems, spread warnings or kudos, use your NEWSLETTER for the purpose. THAT IS WHAT IS FOR!

DSPA monthly lunch meetings are held at Tarentino's Restaurant, on Harbor Drive in San Diego, usually on the third Thursday of the month. All members and their guests are welcome. Please notify Worthington or Saner in advance, if feasible; but come anyway. Date of meeting will be changed, if possible, to accommidate visitors from out of town.
Recent lunch meetings were held as follows:

21 August 1986-11 Members and 5 guests present.
George Rey, Lt.USN, Ass't O-in-C, Unmanned Vehicle Detachment, Submarine Development Group One, spoke about "US Navy Unmanned vehicle Program Status". His unit is manned by 3 officers and 43 enlisted men and is homeported at North Island Naval Air Station in San Diego. An eventual complement of 7 officers and 92 enlisted is anticipated. At present, their principal tool for search is the Klein Sidescan Sonar, using the RCV 225 TV camera and 35 mm camera for identification of targets. They operate a HYDRA RCV from the NOSC Swath Ship TOMALINE. Delivery of two SUPER SCORPIO's is planned in December of this year. A low cost untethered RTV-100 is under development.

18 September 1986--9 Members and 2 guests present.
Otto Orzich, Cdr. USNR, C.O. of USNR Mobile Diving and Salvage Unit One, Detachment No. 319, Long Beach, CA, described the realistic training operations performed by his unit. On their recent mobilization by air to Pearl Harbor, they conducted inspection of the wrecks of USS UTAH and USS ARIZONA for the National Park Service. They performed a detailed examination and mapping of the hulks with emphasis on the state of corrosion of the ships. Cdr. Orzich showed fascinating pictures of the ships before and after the Pearl Harbor attack and their present condition. Incidentally, did you know that there are qualified woman Diving Officers in the US Navy?

16 October 1986--8 Members and 3 guests present.
Bruce Bosshard. Lt. USN, O-in C, DSV SEACLIFF, described their July 1986 diving operations in the Gorda Ridge area off the coast of northern California. SEACLIFF, operatin from the Lockheed support ship TRANSQUEST out of Eureka, CA,,made scientific dives, as weather permitted, to 11,000 ft. depths in the Escanaba Trough at the southern end of the Gorda Ridge. They observed large numbers of extinct hydrothermal vents containing high concentrations of polymetellic sulfides. Gold, silver, platinum, zinc , and other metals were present. On the bottom, near the eastern wall of the trough, currents of 2½ to 3½kts were experienced. The SEACLIFF silver-zinc batteries provided power for dives extending to 18 hours, allowing 14 hours bottom time. The undulating nature of the bottom disrupted sidescan sonar performance , but the Mesotech scanning sonar was very effective in locating the vent chimneys which were very brittle and difficult to sample. A successful

technique was devised in which a chimney was rammed gently so that it toppled into the sample basket. Lt. Bosshard showed color video tapes of remarkable picture clarity and definition taken with a hand-held, relatively inexpensive, Panasonic CCD lowlight level video camera. Auto-focus, auto-exposure, wide-angle features yielded outstanding results both for interior shots and through the viewport. Colors were bright and detailed in views of chimneys, both intact and fractured. Elimination of thallium iodide lights is recommended to obtain better color viewing and eliminate the e.m.i. produced by the lights, interfering with underwater telephone use. Enthusiastic scientist participation in an intensive SEACLIFF training program which qualified them as "Equipment Operators" enabled elimination o the Co-pilot so that two, instead one, scientist could make each 3-man dive.

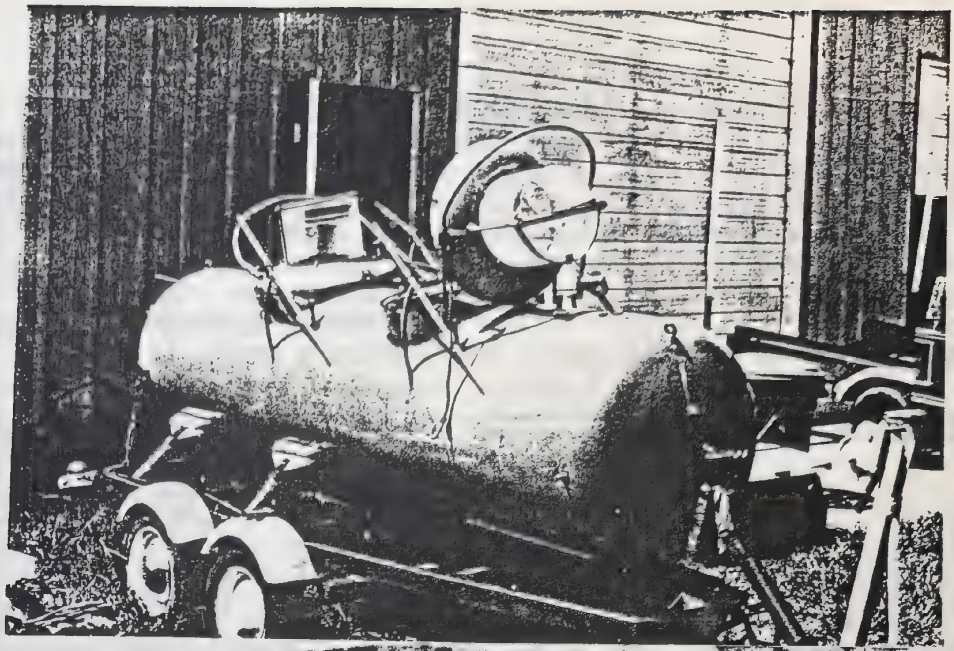
NEWS FROM MEMBERS

Vance Bradley--Precision Oceanics (8/13/86)
"Well, what can I say? My vote sheet came in good time; but, in spite of your advice to 'Vote Now! ' and 'Don't Delay!, I didn't and did, in that order. Resultantly, the election went on (one supposes) sans me. My apologies to one and all.--News from my end beginswith the part about me becoming involved with (gasp!) ROV's. Not full-time, I hasten to add. This particular vehicle is a first generation system designed specifically for use in the nuclear industry (although it will do a good bit more). A number of the commercial builders have tried to interest various utilities around the country in the adaption of oceanic equipment. Apple Machine & Supply of Ft. Pierce, Florida, took a different tack. They developed the tool for the job, rather than modifying the job for the tool. This little unit was developed to fit in some very specific nooks and crannies, and,I am pleased to add, has done so with ease. We are the first group to have such equipment approved and endorsed by a utility for what is basically unlimited access to the primary side (radioactive) of a power plant. We have done a number of inspections in the reactor vesseland environs at St. Lucie Nuclear Plant Unit 2 during a refueling and maintenance shutdown earlier this year--including closeup video of fuel transfer and a mapping survey of the reactor core prior to reassembly.--We have also taken the unit to FP&L's other nuclear facility, called Turkey Point (near Miami),to do inspections in a contaminated water storage tank for Unit 4. The unit has performed very well, to date. I just can't get used to doing this kind of work without being cold, stiff, bent over, and out of coffee. Next trip, I'm going to have someone drip cold water down my neck while we work. I'll pretend it's condensation from the conning tower and no doubt be much happier.--My K-350 is finally coming out of its interminable retro-fit. I have not been able to dive it since ... hmm, quite some time, anyway. We have new main ballast tanks now and quite a few changes in the control systems. It still looks sort of like a Kittredge, but it won't act like one anymore." (9/15/86) "The 2-man sub rescued by the USCG offshore Ft. Pierce a couple of months ago is still in town. Through a fluke, I have run across the guys who were doing surface duty during the dives, and they have the sub (its owner is an uncle or something). I have

arranged to go over for pictures and info and will pass along whatever I hear in the next week or so."

(9/26/86) "Here are snapshots of the Yellow Submarine that flooded and sank with two men aboard recently off Ft. Pierce. It was built by Nautilette, Inc., of Ft. Wayne, Indiana, and has been diving sporadically in the Great Lakes since it was built, somewhere in the neighborhood of twenty years ago. --As I understand it (second hand but reliable information): After an overhaul, the sub was towed to Florida on its trailer for the first-ever open ocean dive. They chose a sandy area about thirty feet deep, less than a mile offshore, and began the dive. The Main Ballast Tanks for this sub are flexible bladders inside the hull, which are filled by valving water in and emptied with an electrically driven pump or a hand pump (back-up). These bladders were in very poor condition. The operator had failed to retrim the boat for salt water operations and attemptedto compensate by overfilling the ballast bladders. One of the bags ruptured, The water ran to the bow, and the sub immediately stood on its nose. To top it all off, the trim system pump failed to operate and they were left with the hand pump. There must have been plenty of adrenalin to operate it as they managed to get the sub pumped downsomewhat; but the suction line is amidships and could not solve the immediate problem. The drop weight was inadequate to the task and hung up, anyway.--They had divers in the water, who attached a buoy and surfaced to call for assistance after assessing the problem. The Coast Guard was called and arrived in due course. After some initial confusion, the sub was winched to the surface and the conning towers were opened. The operator was conscious but weak, and the second man was panicked and had to be assisted. He later passed out, and both were transported to the hospital. Both recovered.--The sub broke free during the confusion and sank (both conning tower hatches were left open) but was relocated and retrieved after three days.--The owner/operator has since decided that the carefree, adventurous, and romantic life of a submersible operator may not be for him. I can't imagine why. Nor will I suggest that his name go up for membership in the DSPA. The gentleman who now owns the NAUTILETTE by default is giving serious consideration to an overhaul and conversion to "barbecue pit" status - an idea which I approved of immediately.--However, if any of our members would like the opportunity to acquire a really unique flower pot (chamber pot?!) ... please drop me a note, and I will pass it on.--On a more serious note, the operators of the NAUTILETTE were in grave peril from the start. The vehicle is in atrocious condition and might have added two more fatalities to the brief list of fatal accidents in our industry. They are licky to be alive. --Had a brief visit at Harbor Branch the other day and met Mike Adams after never quite crossing each other's path for all these years. They are doing some work on JSL-II's forward sphere and have ROV's spread out for miles. "

Patrick Smale--Middleton, Nova Scotia.(ex-DUPLUS II.). (11/1/86) "I was happy to receive my membership items and much enjoyed the last DSPA Newsletter. I have sent along a couple of clippings which may be of some interest. Nothing that "hot", as it seems to have been a fairly quiet couple of months. I will be keeping an eye out for anything else that may show up in the local papers."



NAUTILETTE INC.
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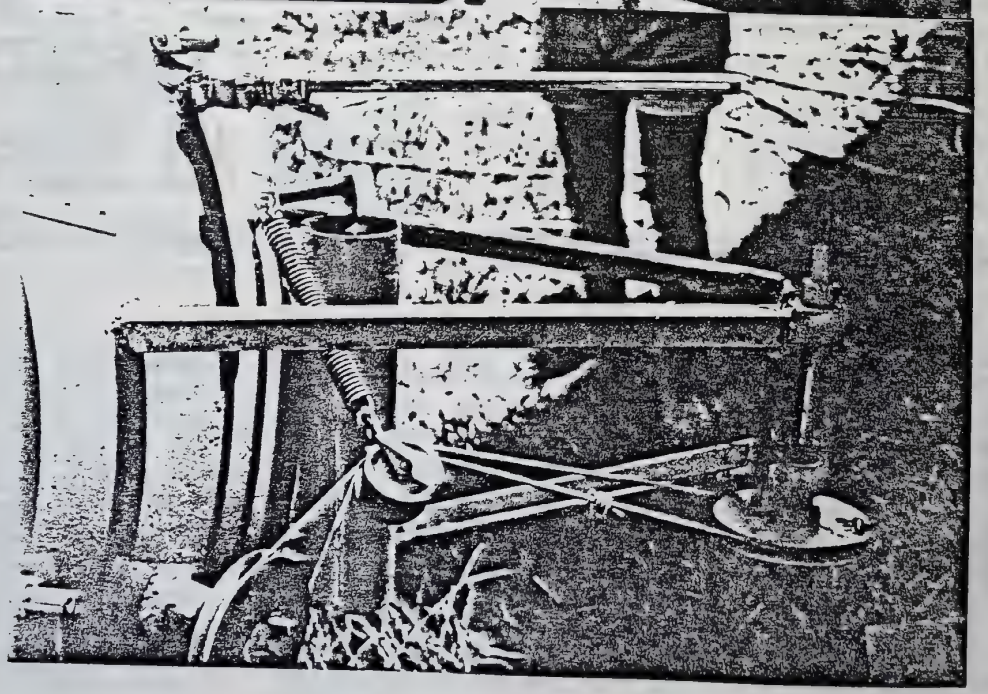
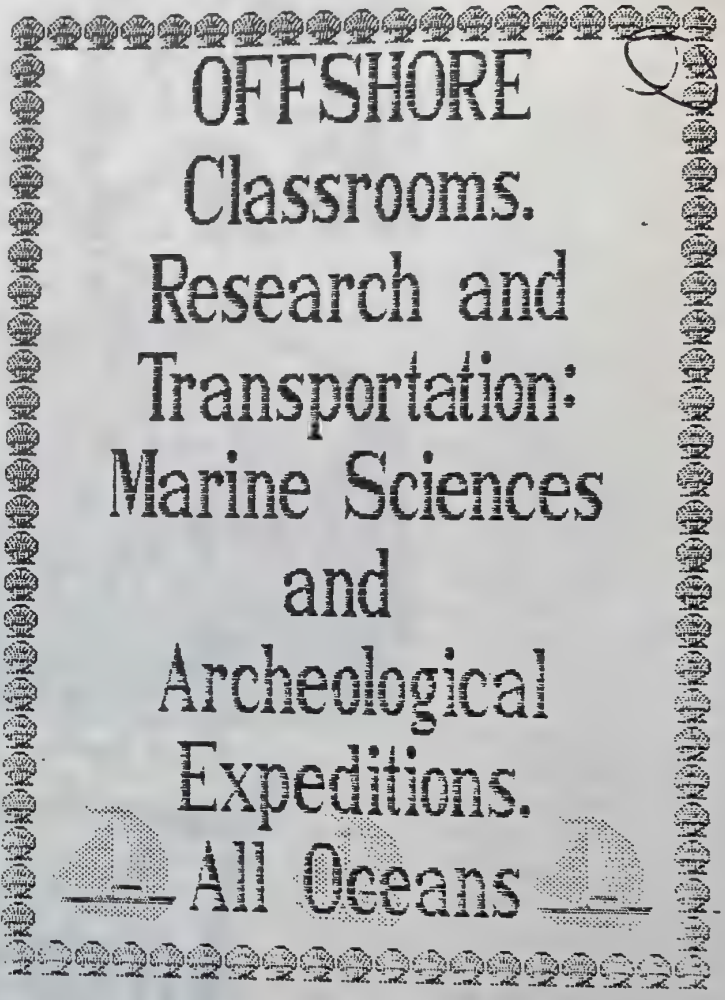
MAX SERVICE DEPTH



Richard Otter--Mahayana Adventures (8/31/86). "I seemed to have lost contact with DSPA, having been on the road - so to speak - for years. If you would be so kind as to forward info on who the Secretary is now so I might catch up on my dues.--Am now working on my PhD and am involved occasionally with AQUARIUS III in Seattle. "Sub Sea Work Boats". They did a magnificent job putting it together. Extremely high tech." (Ed note: Dick, you are just going to have to write more clearly. First reading came out "Sub Sex Work Boats"-- or was that the correct one?)



Richard Slater--NEKTON DELTA (10/30/86). "I'm about 90% sure I will there for the 20 November luncheon. If that is good enough, I will be glad to give the talk. We were supposed to be in Cuba diving in November , but that has been postponed until January. How about a title like:"Submersible Diving Off New England Over The Years"? This would include the early NEKTON dives, ALVIN, DIAPHUS, and the recent Delta dives. I could put together some pretty pictures and give a little geologic and biologic data to go with it. I don't have many pictures of our latest trip, at least not enough to make a full talk out of it.--Yes, I have been attending a series of meetings around the states on future submersible work for

N.O.A.A. We are trying to get a West Coast program going , similar to the very successful New England program. I could also talk a few minutes about the N.O.A.A. program around the U.S.A. and future projects being discussed.--Graham Hawkes has come up with some very interesting designs for future submersibles. You might try to get him to give a talk some month on his research."

Ralph Hollis--ALVIN (11/3/86)
"We now have nine pilots certified on ALVIN. We are supposed to arrive in San Diego on 9 December, 1986."

Roger Cook
Marine Operations Director
Harbor Branch Oceanographic Institution

Having been involved with manned submersibles for many years, I find it humorous and disappointing to read the many articles (Shuttle Salvage Sidelights; *Sea Technology*, July 1986, and others) relating to the recovery operations of Space Shuttle *Challenger*. I only wish that all writers would check first with those individuals who were on site before writing their articles, so they could be more accurate in their descriptions of what actually happened.

For the last twenty years I have been aware of the unique difficulties encountered when conducting operations in the Gulf Stream, mainly from one overriding condition that exists in few other places in the world, which is the strong Gulf Stream (from 2 to 7 knots, depending on the time of year). Your article states that divers, manned submersibles, and even ROV's had a rough go of it because of current problems. The fact is, manned submersibles seldom have a problem operating in high current areas because strong currents rarely exist on the bottom.

The manned submersibles *JSL I* and *JSL II* of Harbor Branch Oceanographic Institution were designated the "work horses" of the fleet during the *Challenger* mission. This was largely because they operate autonomously from surface support vessels. Working divers and ROV's are tethered to ships, which is their major problem when trying to operate in high current areas. The current carries the tether with it, making it extremely difficult or impossible to remain on station.

Since the Gulf Stream is our backyard, we at Harbor Branch have always been aware of the particular problems caused by high current areas. For that reason we developed the ROV *Cord*, which is a fully multiplexed system with an umbilical slightly less than *one-half inch*, thus meeting minimal resistance in currents. That ROV was developed about ten years ago and is still operating today. In fact, *Cord* was the first system deployed by Harbor Branch when we arrived in the Space Shuttle *Challenger* operating area (1300 ft.), to eyeball and examine shuttle debris prior to launching *JSL II*.

Divers operated in shallower water (150 ft. and less) out of the main portion, or axis of the Gulf Stream. The manned sumbersibles *JSL I* and *II* operated throughout the entire Shuttle debris area, from 80 ft. to 1300 ft. Because the Gulf Stream current is strongest near the surface, and 99.9% of the debris located was on the bottom, the current was not a problem. We simply launched our manned submersibles slightly south (the Gulf Stream running north off the Florida coast) of the exact coordinates, so when the submersibles touched down they were very near the contact site.

With a little practice, and knowing bottom depth and current on any particular day, and through the use of state-of-the-art equipment such as acoustic positioning systems, Loran, GPS, and sonar on the submersible, a sub can arrive exactly on station almost every dive. I find my own "one-half depth" rule to be very useful when figuring out launch coordinates. If the water depth is 1000 ft, for example, the current at 500 ft should be very slow, while the current on the bottom will usually be less than .1 knot. We found this to be true during the entire Space Shuttle *Challenger* debris recovery operation.

Technology has come a long way in the last ten years and improvements to operating systems are a constant. ROV's are simply another tool to add to the offshore tool box. Years ago divers were the only tool. Then along came submersibles, then diver lock-out submersibles, and now remotely operated vehicles (ROV's) have joined the team. It is up to managers to look closely at all of the objectives for a particular mission, then pick the best tool or tools for that job, in that particular location, under whatever conditions may exist. The manned submersibles of Harbor Branch did an excellent job for NASA by identifying, rigging for recovery, and recovering key pieces of Space Shuttle *Challenger*.

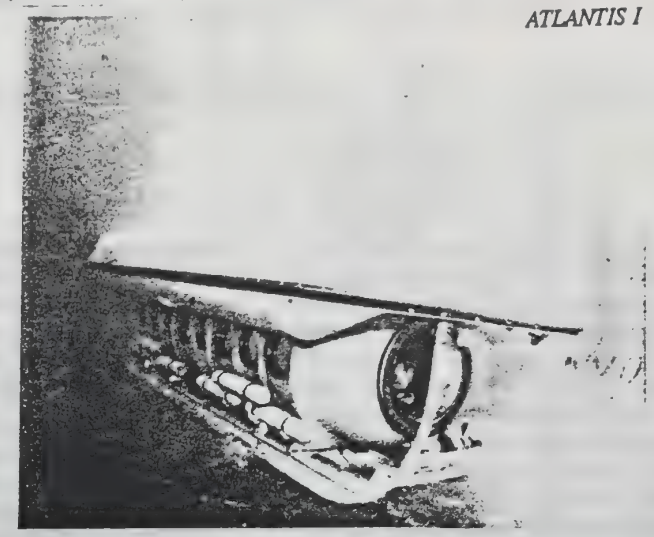
Just as man is needed in outer space, he is also needed in inner space for certain operations. Anyone thinking that just one particular system will complete all the objectives of any mission, anywhere in the world, is sadly mistaken. It will, in many cases, take the presence of man to determine what type of tool can now be built, to replace what man is presently doing. As technology increases from year to year and new systems, tools, and methods become available, man will be needed to determine how these new systems can best be adapted.

SUBMARINE ATLANTIS II ON DISPAY AT EXPO 86

Sub Aquatics Development Corporation, Vancouver, B.C., has their tourist submarine ATLANTIS II on display at Expo 86 in Vancouver. It is moored in front of the host British columbia pavilion.

The first one built, ATLANTIS I, began operation off the Cayman Islands in December 1985 and has since carried over 7,000 tourists in depths to 150 ft. The 50 ft. long submarine carries 28 passengers and two crew members. It has been built to American Bureau of Shipping standards. It is naturally buoyant and is powered down by vertical thrusters. In the event of power failure, the submarine would automatically rise to the surface. In the unlikely event of an emergency requiring the vessel to surface quickly, 4,000 lbs. of lead weight can be jettisoned hydraulically. In addition, the submarine is accompanied by a surface tender, which carries life jackets, fire extinguishers and other safety equipment. The support vessel provides constant underwater communications via telephone, as well as VHF shore communications, and remains above the dive site to ensure surface clearance for the submarine's ascent.

At the Cayman site, ATLANTIS I conducts up to 14 one hour trips each day, including night dives. Cost for a day dive is $45.00; a night dive goes for $55.00. Sub Aquatics has plans to expand the ATLANTIS network to Hawaii, Australia and other areas that offer breathtaking underwater scenery.



ATLANTIS I

RSL NEWS

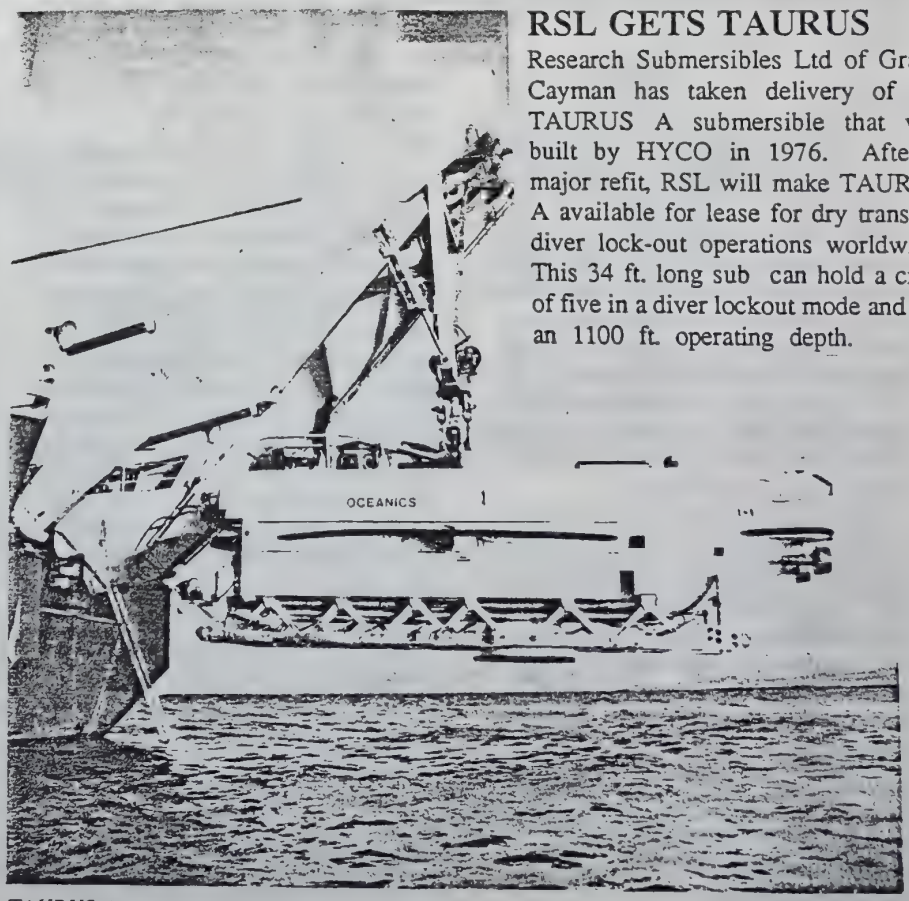
Research Submersibles Ltd of Grand Cayman has acquired PC 1201 from Intersub. This is a 4-man observation submersible and is depth rated to 1000 ft. RSL reclassed the sub with ABS prior to sending her to the South Pacific for a long-term contract in the Northern Mariannas. RSL now operates seven manned subs worldwide for offshore services, marine research and educational tourism.

Meanwhile, RSL sold their PC 1205, a 5-man observation sub depth rated for 1,250 ft., to the MIC Corporation of Japan. They will use the sub for adventure and tourism dives at their hotel on the island of Rota, near Guam, in the Northern Mariannas. RSL is now working to reconfigure the sub including removal of the main internal motor and replacement of the tail cone by a spool piece ending in a 36-inch hemispherical viewport. This "double-bubble" sub will be capable of carrying 4 passengers and a pilot. It will be powered by external thrusters and equipped with a manipulator.

MIC has also retained RSL to supply submersible pilots, engineers and back-up support services. Additionally, RSL will work to train Japanese crews to assist with the program.

RSL GETS TAURUS

Research Submersibles Ltd of Grand Cayman has taken delivery of the TAURUS A submersible that was built by HYCO in 1976. After a major refit, RSL will make TAURUS A available for lease for dry transfer/ diver lock-out operations worldwide. This 34 ft. long sub can hold a crew of five in a diver lockout mode and has an 1100 ft. operating depth.



TAURUS A

Research Submersibles Limited

PC-88 has been diving steadily for more than a year in Grand Cayman. However, it has just been taken out of service and is undergoing a total refit.

PC-1802 starred in a SCUBA WORLD and P.M. MAGAZINE film in July, diving on the Kirk Pride, a shipwreck located at 780 feet beneath the sea off the west wall of Grand Cayman. The sub is currently in the Gulf of Mexico conducting a scientific survey offshore. Soon PC-1802 will return to Grand Cayman to assist the very busy PC-1203 in recreational tourism and scientific dives.

PC-1203 has been diving daily in Grand Cayman since November, 1985. She has recently made dives with illustrious crews. Steve Bell of ABC's GOOD MORNING AMERICA said hello to the world from 800 feet under the sea and Dr. Eugenie Clark, the well known expert in the study of sharks made a night dive to observe her favorite creatures! This week Stan Waterman and Peter Benchley will take their turn filming aboard the sub. PC-1203 also served RSL's first sub school course held in the month of July. These one week long courses with a maximum of six students will be conducted periodically throughout the next year. Please write to Alan Whitfield at our Grand Cayman address for dates and further information on the courses.

PC-1201 has recently been sent to the island of Rota in the South Pacific (near Guam). The sub will be piloted there by RSL pilots, including Bruce Blackburn, and will be involved in recreational tourism.

PC-1205 will soon follow PC-1201 to the South Pacific. The sub will be fitted with a second plexiglass viewport at the stern so will, in effect, be a 'double-bubble' sub, maximizing the observation capabilities for recreational tourism.

P-2 is currently in the United Kingdom but will soon be enroute to Jamaica where it will serve the scientific community. The sub will be based at the Discovery Bay Marine Science Laboratory on the North coast of Jamaica.

As for RSL's staff, Alan Whitfield is now RSL's Vice President in Marketing and he is based in the Cayman Islands. Pilots Allen Wright and Dennis Denton are diving daily in Grand Cayman, so covers can be sent here! RSL staff undergoing pilot training in Grand Cayman are Gordon Smith, Courtney Platt and Peggy Leshikar.

ATLANTIS 1,000TH DIVE

"SKINDIVER MAGAZINE" (OCT. 1986) (VOL. 35/NO 10)

NOV 86

The operators of the *Atlantis* submarine, the world's first 28 passenger submersible and a major attraction for visitors to Grand Cayman, recently held celebrations following the conclusion of its 1,000th dive. In the short time since *Atlantis* began operation in mid-December 1985, its schedule has expanded to include eight dives a day plus regularly scheduled night dives.

Achieving depths of 150 feet off Grand Cayman's famous wall, one of the main attractions is a spectacular view of the 200 foot inter-island freighter, *Carol Lee*, which sank in February of this year and now sits on the side of the wall in depths of 120 to 180 feet.

The *Atlantis* is one of two passenger submarines of this type. Built and designed by Sub Aquatics Development Corporation in Vancouver, B.C., her sister ship, *Atlantis II* was a major attraction at Expo 86.

The scheduled champagne toast became a cookies and punch celebration when the participants for dive number 1,000 turned out to be local Caymanian school children taking part in *Atlantis*' program of making sure every school child in the Cayman Islands sees the beauty of the U/W world that attracts so many visitors and divers.

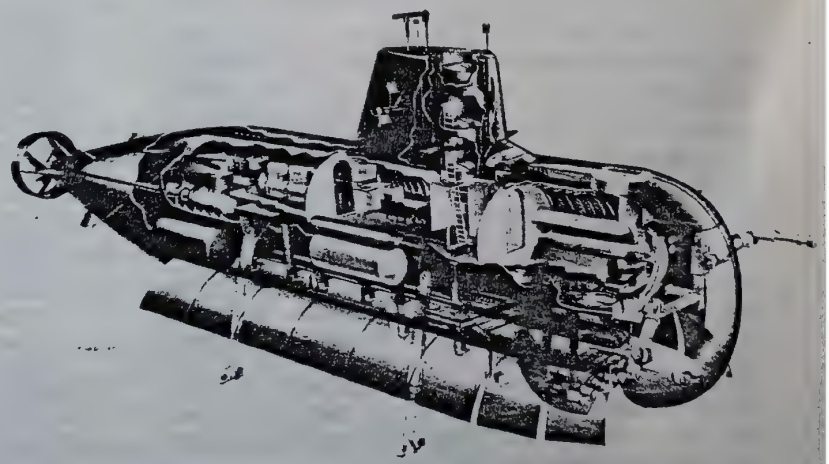
NEW SUBSEA INTERVENTION SYSTEM CONCEPT

TTS Engineering A/S has introduced the SISIS concept which means Surface Independent Subsea Intervention System. The concept is based around MAIS (Multipurpose Autonomous Intervention Submarine). As designed, MAIS will be a 290-ton, 35m long sub that can operate down to 500m, carry 40 tons of cargo and have a submerged endurance of 2-4 weeks with 8 crew members. The sub will operate from a land base; cruise is a submerged condition and will require no surface support.

The submarine has been designed as a multipurpose vessel and will do a number of subsea tasks, such as:

- Survey and inspection of pipelines
- Salvage of lost items (has ability to lift and carry loads)
- Rescue (transfer divers into attached decompression chambers
- Pipeline repair and tie in.

SISIS is the result of a study project for Statoil that required TTS to come up with methods and equipment for installation and maintenance of deep water subsea production systems beyond diver depths. By agreement with Statoil, patents have been applied for and will remain the properties of TTS.



Multipurpose Autonomous Intervention Submarine (MAIS)

NOV 86

Research Submarine Monitors Florida Waters

By Robert Holland

Twenty years ago it was thought submarines were the vanguard of man's invasion of the sea. Such machines could go deeper and stay longer than divers, providing more knowledge in less time. They would no doubt become bigger, better and probably look like high-tech rivals of space vehicles.

History, however, did not unfold as many had guessed. Exploration into inner space never fully blossomed and the high-tech vehicles were few and far between. Today, most researchers have relied on less exotic, small and relatively simple vehicles to explore the seas. And to remain cost effective, the primary projects these submersibles have been involved with (as was the case recently in South Florida) have included number of projects all to be accomplished at the same time.

Such a cooperative approach allows many scientists and agencies to share the results of the submersible's findings. The South Florida project which began July 15 was a cooperative effort between the Caribbean Marine Research Center, the John Perry Foundation and two agencies of the Department of the Interior — the U.S. National Park Service and the U.S. Geological Survey.

Eugene Shinn, Project Chief at the USGS's Fisher Island Station, was instrumental in bringing the groups together and creating the project. The two-man submersible *Delta* was supported by the *Undersea Hunter*, a research ship supplied by the Perry Foundation. Shipboard operations were funded by NOAA's Office of Undersea Research. The *Delta* was provided at no expense by its developer Douglas Privitt.

Delta was the star of the project. Small and simple in design, it carries one pilot and one researcher in very tight quarters. The sub weighs 5,000 pounds, is 15½ feet long and 42 inches in diameter. Its hull is covered with 19 small viewports for observation. Despite its relatively small size, the *Delta* carries all the essential equipment: a mechanical arm for sampling, audio and video documentation equipment, communication and tracking systems linked to the support vessel. With the latter, researchers aboard the *Undersea Hunter* plotted the sub's course on a video monitor, adjusting their position to stay above it. In all, 47 dives lasting from one to 1½ hours were made during the 10-day project. Average depth for dives was 200 feet. The deepest was a jaunt to the continental shelf at 1,060 feet.

Carried out just offshore of Biscayne National Park, the research involved both government and university scientists. The Park covers 175,000 acres and extends offshore to the 60-foot contour — roughly 95 percent of the park is underwater. Much of the *Delta's* time was devoted to research carried out by Drs. Steven Cofer-Shabica and Richard Curry from Biscayne National Park. The results, they hoped, would provide insight for deciding proper management of the adjacent Park.

One of the research team's primary goals was to observe the general health of local coral reefs. Observing deeper reefs would, they felt, help them understand what influenced shallower reefs in the Park. "We found only limited amounts of stressed coral," says park oceanographer Cofer-Shabica. "Although we expected to find a primarily sand bottom on the deep slopes, there was quite a bit of healthy coral. We also hoped to find and map black coral but none was seen."

Using the sub to survey miles of underwater terrain at one to two knots, the scientists were able to do in days what may otherwise have taken months.

A second goal of the Park Service was to find areas of fresh groundwater flow. Although they had limited success, the mapping of such sites has important management implications. The extensive offshore artificial reef placement by Dade County should, according to officials, not be near fresh water flows. This is because the ability for an artificial reef to fully develop near a flow is probably minimal. An ill-placed artificial reef could be wasted, but a well-placed one, they learned, could thrive. Deep water shipwrecks placed in recent years were found to have extensive growth and lots of fish activity.

"We also wanted to see if artificial reefs were pulling fish stocks from reefs and found they probably were not — both were in good shape," says Cofer-Shabica. The other principal, Shinn, was searching for geological deposits and reporting on artificial reefs to NOAA. Shinn did not find the mineral dolmite despite extensive observations and sampling. Dolomite is important as a host to more than half the world's oil produced from limestone. His inventory of artificial reefs, however, will be the basis for a detailed map indicating present location of shipwrecks and the potential for future placement.

Shinn's most illuminating discoveries were not planned. "We observed untended fish traps on every dive," he says. Such untended or "ghost" traps continue to capture fish and because their buoys are gone, the traps are never emptied by fishermen. Legal in Federal waters deeper than 100 feet, the traps are designed to catch food fish and are often deployed like submerged commercial longlines.

"Almost every unmarked trap had fish in it — one had over 30 lobsters which had grown too big to escape," says Shinn. "The worst situation I saw was one trap containing a queen angelfish with a second angelfish — probably the mate — outside. They were repeatedly ramming their heads into the cage, tearing themselves apart, probably in an attempt to mate."

Shinn also observed Miami's submerged sewer outfall at 100 feet. "The outfall had a greater diversity of fish and higher numbers as well," he says. "There didn't appear to be any coral stress either, just a plume of off-colored water that floated to the surface." The outfall has been a favorite site of fishermen for years.

Other researchers included Dr. Alena Szmant-Froelich of the University of Miami's Rosenstiel School of Marine and Atmospheric Science. She was observing scattered deep water corals and patches of productive algae. "It's important to observe these patches," says Szmant-Froelich. "When you sample the environment from the surface it's necessary to realize these patches occur in order to understand the data."

University of Miami graduate student Ellen Prager was in *Delta* to collect data on nodules of calcified algae and marine protozoa. The work which she hopes will be her master's thesis concerns using the nodules as indicators of cold water incursions from deep in the Gulf Stream. Results may suggest why reef development in Florida slows at much shallower depths than in the Caribbean.

After the South Florida project, *Delta* and its support vessel went to the Bahamas for studies at the Caribbean Marine Research Institute in the Exuma Cays and sedimentology work with the University of Miami near Tongue of the Ocean. Prior to coming to South Florida, the *Delta* explored nuclear bomb craters at Eniwetok Atoll in the Pacific. More than 40 devices — including the world's first hydrogen bomb — were exploded there by the U.S. in the late 1940s and 1950s.

The *Delta*, while less exotic than its high-tech cousins, provides researchers with a much needed vehicle. Participants in the South Florida project agreed the submersible made data available which may have otherwise been impossible to obtain.

NOV 86

Richard A. Slater, Ph D.
Consultant
Marine Geology • Submersibles

2 September 1986

Charles E. Simpson
Box 52923
Houston, TX 77052

Dear Charley,

Thanks for your letter to Doug concerning our dives this past summer off the East Coast. Yes we had a very successful season (see enclosed summary sheet) and we are looking forward to a similiar session next year. We have left DELTA at the Perry Oceanographic facilities in Florida as we plan a series of dives off Cuba in November. This will be exciting as I don't believe there have ever been any submersible dives around Cuba before.

As you pointed out, we had quite a few old timers diving with us this summer including the following from the old Nekton days,

Joe Uzman - Woods Hole Fisheries (started diving with us in 1973)
Dick Cooper - Univ. of Conn. (" " " ")
Hal Wanless - Univ. of Miami (dove with us off Florida in 1972)
Gene Shinn - U.S. Geological Survey (Enewetak dives -1984-85)
Jack Kindinger - U.S.G.S. (Enewetak dives - 1984)
Bob Ginsburg - Univ. of Miami (British Honduras - 1971 and 1972)
Bob Wicklund - Perry Oceanographics (dove with me on the SCORE project-1975)
Bob Dill - Ex-Nekton and yes he made the Trieste dives in the early 1960's

I am up to my 958th submersible dive as pilot/observer, hope to break 1000 next summer. DELTA is a super NEKTON, Doug has done his usual fabulous job on the construction. As you can see from the summary, we only lost one day to weather all summer, which meant we can dive in almost any conditions. The sub just keeps running smoothly.

And yes, I was very excited that my wife made her first submersible dive this summer off the Bahamas. She loved every minute of it, as I still do.

Hope this helps bring you up to date.

Rich

SUBMERSIBLE DELTA - Summer 1986

NOAA-NURP-UCAP-USGS-National Park Service-Perry Foundation-
U Miami-MARFAS-Caribbean Marine Research Center

	LEG 1 (New England) June 3- July 9	LEG 2 (Florida) July 13- July 24	LEG 3 (Bahamas) July 26- Aug 6	Summer Total
* Dives	82	48	42	172
* Days Diving	28	10	10	48
* Days No Dive	7	0	2	9
(Travel)	(6)	(0)	(2)	(8)
(Weather)	(1)	(0)	(0)	(1)
* Different Observers	40	35	21	91*
* Dives/Day				
Maximum	5	7	8	8
Minimum	1	2	2	1
Average	2.9	4.8	4.2	3.6
Dive Depth				
Maximum	840'	1060'	1020'	1060'
Minimum	48'	55'	120'	48'
Average	235'	353'	488'	350'
* Dive Time U/W				
Maximum	2hrs45min	2hrs14min	2hrs12min	2hrs45min
Minimum	18 min.	7 min	13 min	7 min
Average	1hr16min	56 min	55 min	1hr 5min
U/W Time/Day				
Maximum	6hrs19min	5hrs29min	5hrs11min	6hrs19min
Minimum	51 min	2hrs17min	3hrs 3min	51 min
Average	3hrs40min	4hrs40min	3hrs50min	3hrs55min

* Some observers on two different legs

Dives by science - Biology (93), Geology (57), Demos (18)
Arch/Eng. (4)

The Feenan Jennings panel report—"New Directions for NOAA's Undersea Research Program"—makes no bones about the future of the "O" in NOAA but addresses the lack of funding and commitment on a national rather than agency scale. The report is one of several published or expected from panels of industry/government/academic experts convened by NOAA administrator Anthony J. Calio, who is in part responding to criticism that atmospheric sciences were claiming a larger share of funding at the expense of traditional ocean research.

The report says ". . .It is in the national interest that the U.S. maintain a world leadership position in ocean exploration. . . ." Jennings and his colleagues point out that it takes 10 to 20 years to field a technology from development to operation. Our national advantage in undersea technology has been lost because of a lack of adequate support in the past 10 years and we must start now to rebuild that lead.

We are in particular agreement with the recommendations that NOAA get on with aggressively accepting its mandated charter and assuming responsibility for focusing and implementing a national undersea research program. The other agencies operate under relatively clear mandates to provide ocean surface data via satellite (NASA) and fundamental science support (NSF), but now NOAA needs to take the lead for providing the missing link; observations and measurements in the wet dimension for those global studies planned by the oceanic sciences community.

Another set of recommendations we endorse is that NOAA should give serious priority to leasing commercially available submersibles for better scientific access to state-of-the-art vehicles, and should begin plans for development and operation of a 7000-meter-depth submersible by 1995 and another 10,000-meter system for 2000 and beyond.

To paraphrase our train buff, we think it's high time this nation and its administration mind the consequences of missing what might be a time-critical opportunity. /st/

Scientists hit pay dirt on ocean floor

By Steve LaRue
Staff Writer

Marine scientists prospecting in a 30-foot Navy submarine have discovered large deposits of copper, lead, zinc, gold and silver 11,000 feet under the sea, they announced on returning to port here yesterday.

The expedition was conducted by a combination of experts from universities, the Navy and several federal agencies. It was described as the first successful mineral hunt in the 200-mile offshore Exclusive Economic Zone declared by President Reagan in 1983.

All of the minerals can be mined more economically on land, but the underwater deposits discovered in this dive were described as a resource for the future.

Lt. Bruce H. Bosshard was the captain of the Navy's 30-foot Sea Cliff deep submergence vehicle that made eight dives, taking scientists to the bottom of the sea to find ore and scoop samples. The sub docked yesterday afternoon aboard its mother ship, the Transquest, owned by Lockheed Corp.

Mark Holmes, marine geologist for the U.S. Geological Survey, told of gliding in the submarine over patches of minerals the size of football fields.

"We were successful beyond anyone's wildest dreams," Holmes said.

"Some of those rocks contain appreciable amounts of gold and silver. Deposits that rich in silver, were they to occur on land, would be front page news."

The minerals were found in a 150-mile, undersea rift called the Gorda Ridge, about 175 miles west of the California and Oregon borders.

This scar on the ocean floor is one of the seams where two vast segments of the earth's crust are slowly pulling apart. Here, jets of scalding water blanket the ocean floor with minerals they bring from the earth's interior.

"We know now that this area has very significant resources. We didn't know that before," said John Smith, task force director and spokesman for the Minerals Management Service, a branch of the Interior Department.

Many silver mines on land have less promising ore than was found here, Holmes said, but the costs and problems of mining 11,000 feet under the sea will discourage private mining enterprises, perhaps for decades.

He suggested, though, that miners of the future might go underwater seeking precious metals and recover copper, lead and other minerals as byproducts.

"Even if industry decided to exploit these minerals tomorrow, it would take them 10 to 15 years just to develop the technology," Smith said.

The exploration focused on two volcanic features pinpointed by a 1984 expedition that produced sonar maps of the ocean floor out to 200 miles that were as clear as aerial photographs.

"There are seven to nine more volcanic domes down there that we haven't even looked at" but seem sure to harbor even more deposits, Holmes said.

Smith said: "We've just scratched the surface."

The San Diego Union/Greg Vojtko

Mark Holmes, U.S. Geological Survey marine geologist, holds ore samples scooped from the bottom of the sea.

Examination of Pacific Black Smokers Underway

Following the successful journey to the floor of the Atlantic Ocean in search of the first active high-temperature hot vents found there (*Sea Technology,* August 1986, page 79), oceanographers are scanning the Gorda Ridge in the eastern Pacific Ocean.

The team is looking for active high-temperature vents on the ocean bottom: seafloor cracks through which mineral-rich fluids boil up into the water. The oceanographers hope to prove that seafloor spreading in the eastern Pacific has the same consequences as spreading along the Juan de Fuca and Mid-Atlantic Ridges.

Dr. Edwart T. Baker of NOAA's Pacific Marine Environmental Laboratory and Dr. Peter A. Rona, co-chief scientist from NOAA's Atlantic Oceanographic and Meteorological Laboratory in Miami—and leader of the recent Atlantic black smoker expedition—are seeking geysers of hot water, so-called "black smokers," discharging black clouds of metal particles from the seafloor.

Last year scientists from NOAA, the U.S. Geological Survey, and Oregon State University found chemical indicators in water samples that venting is occurring on Gorda Ridge.

Originally marine geologists believed hot, metal-rich geysers vented only at fast-spreading sites, but NOAA expeditions to the Mid-Atlantic Ridge and the discovery of the chemical indicators on Gorda Ridge have proved otherwise.

'Picture Perfect' Return To the *R.M.S. Titanic*

By David M. Graham
Editor

"Picture perfect cruise" is the way expedition leader Dr. Robert D. Ballard described his second trip out to explore the fabled lost luxury liner. Unofficially dubbed *"Titanic II"* by some, the virtually trouble-free July expedition was again carried out by Woods Hole Oceanographer Institution and Ballard with funding from the Office of Naval Research.

This time, however, the searchers got close-up looks at the wreck and tested an impressive new remotely operated vehicle prototype called Jason Jr.

This was also the team that had joined last year with the French ocean agency—Institute of Research for Exploration of the Sea (IFREMER)—to look for the *Titanic* and test a pair of sophisticated deep ocean survey systems. (See *Sea Technology*, October 1985, page 70ff.)

The U.S. and France this time around, however, were expected to launch separate *Titanic* explorations (*Washington Letter of Oceanography*, 20:13, June 30, 1986). The French cancelled their excursion, though, after determining there was not enough financial backing for a solo trip. A spokeswoman for Woods Hole said, "The french estimated the cost for a trip to the *Titanic* to be around $2.1 million. In a public statement released (recently), they said they raised only half that amount." Ballard's three-week mission aboard *Atlantis II* was expected to cost only $500,000.

Other sources speculated to *Sea Technology* that the French were still smarting from last year's near-miss with their advanced remote acoustic system (Thompson-CSF's SAR) and the subsequent legal skirmishes over rights to release *Titanic* photos from the September 1985 expedition.

'Jay Jay' Stole the Show

While the veteran WHOI/Navy submersible *Alvin* took honors for carrying Ballard and two crew members down nearly 4000 meters for the first in-person look at the wreck in almost three-quarters of a century, the diminutive ROV dubbed "Jay Jay" stole most of the show.

A dozen independent imaging systems aboard *Alvin*, Jason Jr., and the ubiquitous ANGUS (Acoustically Navigated Geological Underwater Survey) towed camera sled all delivered a total of 57,000 still photographs—in color and black & white—along with more than 50 hours of videotaped images. But Jason Jr. took its video and still cameras down the Grand Staircase and into the eerie depths of the *Titanic* where *Alvin* and her human crew would dare not venture. Purpose of the expedition, Ballard said, was to conduct sea trials on the Navy-funded "flying eyeball" that is the forerunner of the still-developing Jason ROV, which will be integrated as a close-up inspection and sampling tool for Argo. Jason will carry high resolution color video cameras and advanced manipulator arms, Ballard added, for work at expected depths of 6000 meters. Argo, of course, was the star of the September 1985 expedition that found the *Titanic* wreck site some 725 kilometers southeast of Newfoundland.

The Navy, according to Secretary of the Navy John F. Lehman Jr., has a lot riding on the success of Argo and Jason. He described the $2.8 million WHOI/ONR project as an end to "a long hiatus in new initiatives in developing deep ocean research technology."

Rationale behind the project, Navy spokesmen have also pointed out, has always been that finding objects—disabled submarines, lost nuclear weapons, or hydrothermal vents to name a few—on the deep ocean seafloor has always been a difficult task. Conducting such searches from a submersible can be slow and quite hazardous.

Two major development steps remain, according to Woods Hole, before the final Jason vehicle can operate from its mother vehicle, Argo. Ballard, who also heads Woods Hole's Deep Submergence Laboratory (DSL) that holds the ONR contract, explained that a new dynamic positioning system will have to be designed and installed on WHOI's *R/V Knorr*, which will in turn act as mother ship to Argo. Also on the drawing board is the design of an advanced fiber optic cable for connecting Argo/Jason with the control center aboard the *Knorr*.

The dynamic positioning system is needed to hold Argo still while Jason swims in and out of its "garage" while working at depths to 6000 meters. The fiber optic cable will transmit the high-quality color television signals to scientists in *Knorr's* color studio/Argo control room.

Bypassing Some Jason Systems

The *Titanic* expedition last July gave DSL engineers the chance to test Jason Jr. and all its systems while bypassing the need for the dynamic positioning and fiber optic cable systems for the time being.

"We were learning about Jason's tether, the tether management system, all the components which are going to have to be operated remotely," said Jason project engineer Chris von Alt. "We had a chance to look at those systems in person in the deep ocean. What we did was 'telepresence' in a way."

As was true of the 1985 test of Argo, several familiar oceanographic companies—and one newer entry from Japan—were involved in the success of Jason's testbed. Jason Jr. Benthos Inc., Sony Corp., DeepSea Power & Light Co., and Colmek Systems Engineering were key players on the 12 imaging systems carried to the *Titanic* site by Alvin and the small ROV.

Jason Jr. carried a DSL-modified Sony Model XC-117 charge-coupled device (CCD) video camera, a Benthos Model 378 still camera with a capacity of 400 35-mm frames, and a Benthos Model 3881 strobe with 100 watt-seconds output. A pair of 250-watt full ocean depth rated lights from DeepSea Power & Light Co. complemented the Sony video system.

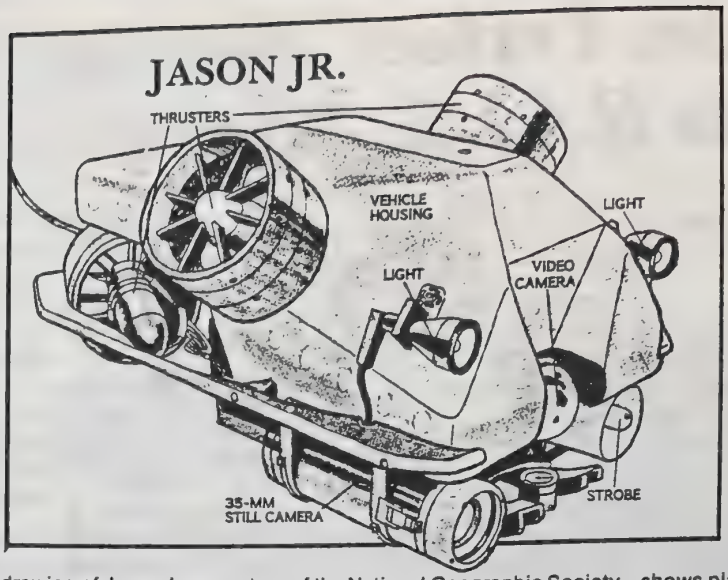
Sea Technology was told by von Alt that Jason Jr.'s video camera was modified by removing the CCD integraded circuit chip and remoting it away from the camera body so that it could be tilted a full 170° range. The lens and the chip were attached to a motor-drive belt to provide the 170° "pitching."

"We did all that interfacing here at Woods Hole but still retained the

high quality video the XC-117 can put out," von Alt added.

A near-duplicate of Jason Jr.'s cameras/lights suite was installed on what Ballard described as "Big Bird" —a peculiar construction that incorporated an unmodified Sony XC-117 video camera, the Benthos camera and strobe combination, and this time a pair of 150-watt DeepSea lamps—all mounted on *Alvin's* hydraulic manipulator arm.

Metal reflectors on the Big Bird lamps—designed by the San Diego firm's president, Mark Olsson—delivered "excellent throw. . .something like 15 to 20 feet in distance," according to von Alt.



This drawing of Jason Jr.—courtesy of the National Geographic Society—shows placement of the ROV's Deepsea lights, Benthos camera and strobe combination, the Sony video camera housing, and the Woods Hole-developed thrusters.

Testing Control Theories

The small vehicle itself was also used to test some strongly held theories on control. All the thrust, both horizontal and vertical, passed through the ROV's center of gravity. "We went to a great extent in design to minimize the disturbances normally created by running the thrusters. Jason Jr. should have been in fact very easy to control. And we found that to be true," von Alt said.

The thrusters were DSL's own design, with all the propeller and duct work calculations done in-house. Kollmorgen supplied the thruster motors.

Holding it all together was the basic vehicle frame and flotation material. Design and layout credit goes to DSL engineer Andy Bowen, who oversaw the assembly and machining of the frame and the Emerson & Cuming syntactic foam by Astronautics from nearby Marlboro, Massachusetts.

The link from Jason Jr. to *Alvin* (and later to Argo) was an 85-meter-long electrical/tether cable again designed by DSL engineers but manufactured by Vector Cable Co. Vector also did the cable terminations while Brantner & Associates supplied its Sea Con connectors rated to Mil-spec.

Tether management was the task assigned to the hydraulic equipment and slip-ring assembly supplied by Ulvertech. "Our laboratory specified the system, a very sophisticated device with level wind that weighs only 160 pounds," von Alt stated. The 2-horsepower system that saw service on *Alvin* for the historic dives will be scaled down for Argo and will operate with only 1/3-horsepower.

Jason Jr. was operated from inside *Alvin* by a DSL-designed control unit that looked for all the world like a pair of high-tech handlebars with a small monitor attached. Software for running the small ROV via the control console was the brainchild of the lab's Jim Newman. "He and Andy Bowen were among the unsung heroes who never got to go to sea," von Alt said.

Alvin did play another role beyond just acting as a mother vehicle to the ROV and a sightseeing bus for the Woods Hole and Navy researchers. She played the part of Argo further by carrying a Colmek SIT (silicon-intensified target) camera mounted up on her hull. The down-looking system—complemented again with 600 watts of light from a bank of DeepSea units on *Alvin's* stern—provided what von Alt called "the really tremendous black & white footage, especially during the pirouette over *Titanic's* bow."

Finally completing the list of imaging systems was the brow-mounted stereo cameras (Benthos Model 372s) and strobes and the Benthos "utility camera" attached to *Alvin's* science tray atop Jason Jr.'s garage.

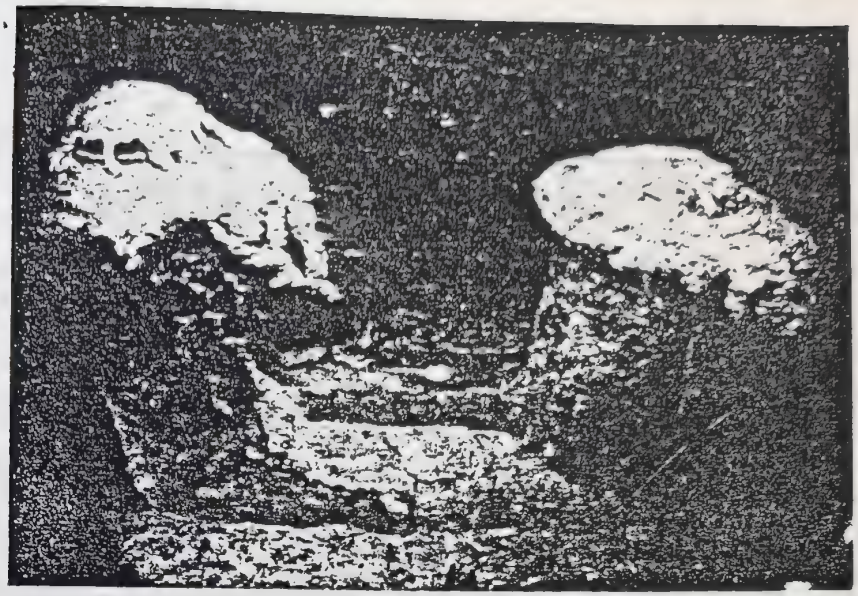
The 'Other' Titanic Pictures

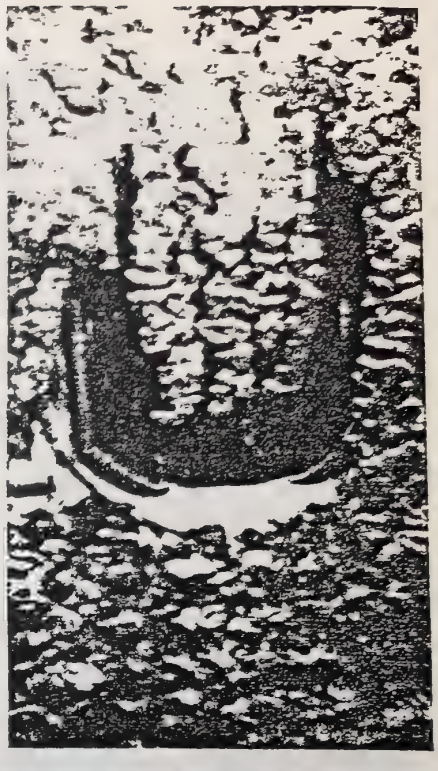
While the public was once again mesmerized by the eerie *Titanic* footage on television news, the vast majority of the photographs and videotape has yet to be released by Ballard or Woods Hole. Many of the images, however, are duplicates or part of the series taken by ANGUS. The latter spent more than 100 hours on the bottom at night doing "the real lion's share of the surveying," according to Ballard, for photo-documentation of the entire wreck to create a mosaic.

Still another objective of primary interest to Ballard is to finish the film documentation of *Titanic* begun during the final four days of last summer's discovery cruise with the French aboard the *Knorr*. That filming effort has two primary purposes, said Ballard. The first is to capture carefully on film the present state of *Titanic* should other organizations actually attempt to salvage her. Ballard is totally opposed to any such salvage attempt as he believes it would destroy what now remains of *Titanic*.

The second purpose of the filming effect is to demonstrate the rapidly evolving technology called "telepresence" that should, in the future, eliminate the need of salvaging historically important wrecks like the *Titanic*. Ballard believes that through the use of advanced robots like Jason, society will be able to visit historic sites like the *Titanic* and tour their exterior and interior compartments as if visiting a museum.

The cold temperatures, great pressure, absence of sunlight and the slow sedimentation rates in the deep sea create a preserving environment for such historic finds, which have a better chance of surviving the ravages of time than bringing them to the surface where the now torn remains would rust and deteriorate. Through this documentary effort, Ballard hopes society will conclude that *Titanic* is best left where it is./st/





A pair of bollards (left), used to secure mooring lines on the ill-fated *Titanic*, were captured by remotely operated cameras deployed from *Alvin* after a 2½-hour descent from Woods Hole's support vessel, *Atlantis II*. Another surprise (upper right) was the extensive covering of "rusticles" that here cover one of the vessel's portholes. In addition to the rust, Ballard and his colleagues reported that virtually every bit of organic material--such as wood planking--had apparently long since been eaten away by marine organisms. But strong seafloor currents and suspended particles kept this copper kettle from *Titanic's* galley polished as clean as the night the vessel sank off Newfoundland 74 years ago.

Texan hopes to attract French scientists in Titanic salvage try

The Texas oilman said any artifacts he would keep from a salvage expedition would go to the Smithsonian or to maritime museums.

WOODS HOLE, Mass. (AP) — Members of the Titanic expedition want items from the sunken luxury liner to stay on the sea floor, but a Texas oilman says he'll go after the artifacts.

"I can't see them just lie there and be absorbed by the ocean floor," said Jack Grimm. He wants to pay a crew from the French Institute of Research for Exploration of the Sea to retrieve items such as wine bottles, dishes and pots and pans that have littered the ocean floor since the Titanic struck an iceberg and sank 74 years ago.

The French institute teamed up with a crew from the Woods Hole Oceanographic Institution last year to find the vessel but did not make the return trip last month, apparently because of lack of funding and a rift with the Woods Hole group.

"Mr. Grimm is very interested in our technology," said Francoise Vitali-Jacoo, spokeswoman for the institute. "But no, we haven't already reached an agreement."

Grimm, who has made unsuccessful searches for Noah's Ark and the Loch Ness monster, is confident he will reach an agreement with the French for a 10-day expedition next July that he says would cost $600,000 to $700,000.

"In my discussions with (the French), we discussed the recovery of some of the artifacts and share ownership in them jointly," said the founder of Grimm Oil Co.

The institute has a minature submarine similar to Alvin, a submersible the Woods Hole team used last month. The French sub could scoop up items with mechanical arms and bring them up.

Grimm said he was not moved by the plea of Robert Ballard, chief of the two Titanic expeditions, to allow the ship on which 1,513 died to "finally rest in peace."

"I just think it's something that millions of people would like to see done, and share in the excitement and experience of retrieving some of the treasures of the Titanic," Grimm said in a recent telephone interview from his Abilene, Texas, office.

Ballard has said anyone attempting a salvage operation is not likely to get his money's worth.

His crew found that virtually all the ship's wood is gone and there is nothing organic left, except for one patent leather shoe.

Most of the wreck is rust-covered, they said, except for gleaming copper pots and pans still hanging in the galley and a crystal chandelier dangling in a dining room.

Grimm said the items should be displayed at the Smithsonian Institution and maritime museums, and that he has no desire to sell them.

He said he would not take items from the inside of the ship because it would be difficult, if not impossible, to send the manned submarine inside.

The oilman said he would concentrate on the "debris field," where artifacts from the ship fell when the Titanic struck bottom 2½ miles down.

Personal items would be returned to families of victims if possible, he said.

Woods Hole spokeswoman Anne Rabushka said she knew nothing of the French institute's discussions with Grimm.

Last year, the French did most of the preliminary work in narrowing down the possible area where the ship went down about 450 miles southeast of Newfoundland. An unmanned Woods Hole submersible vehicle controlled from a ship found the wreckage.

But a rift occurred when the French team felt Ballard hoarded press announcements on the historic find. Rabushka confirmed the rift but said Ballard did everything he could to share the credit.

The U.S. Navy, which paid for last month's mission, said it agrees with those who say the Titanic site should be left alone, but adds Grimm or other salvagers cannot be kept out.

Dean E. Cycon, a Woods Hole research fellow and an attorney specializing in maritime law, wrote in a recent edition of Oceanus, the journal of the Woods Hole institute, that "under present international law, the wreck of the Titanic is fair game on the high seas."

KITTREDGE SELLS ANOTHER SUBMARINE

Kittredge Industries of Warren, Maine, has produced its 40th submarine. This one was sold to the University of Nagasaki, the second Japanese research group to buy a Kittredge-made submarine.

Named *Seibe* (ancient name for the city of Nagasaki), it was personally certified by Captain George Kittredge, USN (Ret.). Operating off the university's new 1000 ton training ship *Nagasaki Maru*, the submarine was first lowered in an unmanned mode to 500 feet. It was later operated by Captain Kittredge at its standard operating depth of 350 ft.

The sub is a Kittredge 2-man K-350 L model.

SAFE USE OF ELECTRICITY UNDERWATER

A new code of practice which provides expert guidance to everyone concerned with the use of electricity underwater, including designers, manufacturers and users, has been published by the Association of Offshore Diving Contractors (AODC).

Called *Code of Practice for the Safe Use of Electricity Under Water*, it is based on a Department of Energy document published in 1982. The new code has been expanded to be of use to everyone in the industry. It incorporates the latest information available from research projects and the experience of a wide cross section of interested organizations. Thes include the AODC itself, the Admiralty Research Establishment experimental diving unit, the Department of Energy diving inspectorate and electrical inspectorate, the marine directorate of the Department of Transport, Det Norske Veritas, the Institution of Electrical Engineers, MaTSU/ UKAEA, the Norwegian Petroleum Directorate, the Underwater Engineering Group and the UKOOA.

The Code has been endorsed by the Norwegian Petroleum Directorate, the UK Departments of Energy and Transport, the Department of Labour in Ireland and the Canada Oil & Gas Lands Administration as being suitable for underwater use.

The Code is divided into three sections dealing with an overview of the use of electricity in an underwater environment, present day standards and practices for installers and users and guidance to the system designer. Highly recommended.

This publication is available for Asia and the Americas through Windate Enterprises, Inc.

WARNING!

Do Not Operate Electrical Equipment Underwater Without Referring To:

CODE OF PRACTICE FOR THE SAFE USE OF ELECTRICITY UNDERWATER

New from the Association of Offshore Diving Contractors (AODC), the Code covers all types of electrical equipment used by the diver or submersible/ROV pilot. This fully comprehensive Code is a must for all subsea equipment designers, manufacturers, users and others. Over 100 pages are devoted to this important subject; appendices and glossary are included. The Code has been approved by safety authorities worldwide.

The Code is priced at $49.50 plus $6.00 first class air postage for Asia/ Australia.* US Funds/US Banks only.

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ALVIN happenings.

Schedule. The present North Atlantic cruise concludes on the 14th followed by a 5 day lay over here in Woods Hole. NOAA geologist Bill Stubblefield will start his Delaware Canyon geology dives series on the 20th. Into Charleston S.C. on the 7th of October to change scienctists and gear. Leave Charleston on the 11th with new scientists for transit to the Gulf. Gulf of Mexico biology dives until the 22nd when AII will enter Tampa. Underway for more biology on the Gulf vents on October 26th and return to Tampa on the 8th of November. Underway finally for Panama on November 12th. Thru the Canal with a stop in Balboa 21st and 22nd then underway for Panama Basin dives on the 23rd. This cruise concludes in Punta Arenas Costa Rica on 28 November. From here straight transit to San Diego.

So, Tampa 23, 24, 25 October and 9, 10, 11 November. NO dives are scheduled between Tampa and Panama but, I will take Panamian stamped covers to be documented during the Gulf of Mexico dives and posted in Panama. Also, will take Costa Rican covers for posting in Punta Arenas the end of November.

The new ALVIN is working very well. We have had the usual post-overhaul problems - all of which have been corrected. Next year's preliminary schedule shows a very ambitious 18[illegible] dives - all of which will be deep and long. ALVIN/AII travels next year will cover the Pacific from San Diego to Hawaii to the Mariannas to Japan and back across the Northern Pacific to Seattle.

U.S. agrees to help look for sunken mystery sub

WASHINGTON — Responding to a request from Israel, the Pentagon has agreed to spearhead a search off the Egyptian coast for an Israeli submarine that mysteriously disappeared more than 18 years ago, sources said yesterday.

The sources — Pentagon officials who agreed to discuss the matter if they were not identified — said the Joint Chiefs of Staff last Thursday approved Navy participation in the search for the Dakar.

The search, to be paid for by the Israeli government and conducted in three phases, is expected to last roughly 90 days. It will begin late this month as a joint project of the United States, Israel and Egypt, the sources said.

The Egyptian participation is crucial, because bits and pieces of debris found over the years have convinced Israel the submarine went down within Egypt's 12-mile territorial limit.

What the submarine was doing that close to Egypt remains a mystery.

The Dakar, a diesel-powered submarine with 69 men aboard, disappeared in January 1968 after leaving England on its maiden voyage bound for Israel.

An Israeli salvage vessel, with Egyptian liaison officers aboard, has tried unsuccessfully three times over the past four years to locate the Dakar, recover the bodies and solve the mystery of what happened to the vessel.

According to one Pentagon source, those searches were not very comprehensive, in part because of the Egyptian concerns about providing the Israelis free access to their waters.

The Pentagon sources said Israel was prompted to call on the United States following last year's dramatic discovery of the missing luxury liner Titanic. Equipment developed for the Navy was instrumental in finding the Titanic.

Israel first asked for U.S. help in December, but the project ended up being put off because of the need to conduct salvage operations off Florida following the Jan. 28 explosion of the space shuttle Challenger.

According to the sources, the current search plan calls for the establishment of a base camp on shore near the Egyptian city of Alexandria. The first phase will involve the dispatch of U.S. P-3 Orion sub-hunting planes from the NATO base at Sigonella, Sicily.

The planes will attempt to fix the location of the missing sub, at which point a privately owned salvage vessel under U.S. Navy contract will move in to conduct a sonar search of the wreck.

The third phase will involve "a detailed undersea survey of the area," the sources said.

JAPANESE RESEARCH SHIP LOST AT SEA

On June 17, 1986, the newly-built shallow ocean research ship *Helios* sank off the coast of Soma, Japan. The cause of the accident remains a mystery. She was 26 meters long and had the bridge located on the high bow deck. A research submersible weighing two tons and a large crane to lower it were placed on lower stern deck.

Helios left the port of Shimizu on June 16th and headed for Happoro, Hokkaido on her maiden voyage to perform a survey of octopus resources. At noon on the 17th, she reported via telephone a smooth voyage. Then, five hours later, she relayed that she was heading north, getting into stormy weather and if it got worse, she would seek refuge. That was her last transmission. Two bodies were later recovered, including the captain of the *Helios*. Japan's Second District of Marine Security Headquarters concluded she sank instantly for some still-unknown reason. Possibilities are:

- She was capsized by large waves from the stern or the side due to a sudden change in weather.
- She was hit by some other ship during thick fog and this other ship did not report the accident.
- The engine room was flooded through an open hatch which was forgotten to be closed.

Of the three, the first is the most likely, according to specialists investigating the accident. There are some views that the center of gravity was too high and the submersible and crane on the stern deck made her unstable. However, officials at Fujishin Shipbuilding, where she was built, said that four tons of ballast were added to the bottom of the ship.

Helios was owned and operated by Japan Shallow Ocean Research Laboratory (JSORL), which was established in February 1984 by parent company, Suruga Seiki.

UNDERWATER TECHNOLOGY HISTORY ON THE BOTTOM OF THE BERGEN BAY FJØRD

by Harald Lyngmyr, Marketing Coordinator,
Norwegian Underwater Technology Center, A/S.

Translated to English by Einar Dahle, Assistant General Manager,
Petroleum Department, Bergen Bank

[Special to SUBNOTES]

In 1931, it was a troublesome problem tc get rid of once and for all. Today, it is underwater technology history. This is the story of the submarine *Nautilus* that found its final destination on the bottom of the Bergen Bay, located on the west coast of Norway, in 350m (1150 ft) of water.

The ambitious plan to cross the Arctic Ocean from Spitsbergen to Alaska went wrong. The main reasons were bad planning and no trial of the concept before the actual start.

Today's offshore related underwater activities are relatively new, but they have their origin through the development of which *Nautilus* was part. It's natural, therefore, for the Norwegian Underwater Technology Center A/S (NUTEC) to clarify this story for the public. NUTEC looked through their files in 1984 in order to find the exact position of the *Nautilus*. With reference to papers and films of 1931, its position was known roughly. The actual depth where the *Nautilus* was supposed to be was more than NUTEC's own CHECK MATE [2-man bubble sub] could handle. NUTEC, therefore, went into an agreement with a local company, Sjøteknikk A/S, to provide positive identification and the exact location of the submarine that sank in 1931 near the NUTEC facility. That data was provided in February 1984 by Sjøteknikk's own-produced ROV, "Max."

Nautilus

Nautilus is the Latin word for any mollusk of the genus *Nautilus* found in the Indian and Pacific oceans and having a spiral shell with a series of air-filled chambers. But through Jules Verne's novel, *A Voyage Under The Sea*, the name has become attached to submarines. Actually, the first submarine with the name of "Nautilus" was launched as early as 1801, 70 years before the novel was written, and was designed by Robert Fulton.

The American submarine designer and engineer, Simon Lake, was inspired by the Jules Verne novel when he was a boy. As an adult, he competed with another famous submarine engineer, John P. Holland, for deliveries to the American Navy. Simon Lake built his first submarine, *Argonaut*, in 1896. It was financed through private institutions and was one of the first submarines built for peaceful tasks. Later, Mr. Lake delivered submarines to Russia, Austria and Germany, but it was not until 1912 that he won a contract from the U.S. Navy to build the submarine *Seal*. At 161 ft. in length, *Seal* was the largest submarine the world had ever seen. Other famous work by Lake included the first usable periscope and the construction of locks in order to be able to transfer personnel and goods to and from a submerged submarine.

In time, Lake built O-class submarines for the Navy, one of which, O-12, was later modified to noncombatant status and turned into an oceanographic expedition submarine. It was christened *Nautilus* in the presence of the grandson of Jules Verne. The purpose of the reconstruction was to realize an old dream of crossing the Arctic Ocean under the ice. The dream was probably as old as the submarine. Bishop John Wilkins published a book in 1648 describing a submarine's excellence for the exploration of polar regions. In touting the idea, the book described the polar submarine as being "safe from ice and extreme cold, which make the passages near the poles dangerous."

Then, some 283 years later, one of the bishop's descendants, Sir Hupert Wilkins, tried to realize this dream without knowing his ancestor's prophecies. However, it wasn't until another 27 years in 1958 that the voyage below the polar ice was finally realized by a nuclear-powered submarine built by the company established by John P. Holland, Simon Lake's earlier competitor. This submarine had also been given the name *Nautilus*.

Sir Hupert Wilkins

George Hupert Wilkins was born in southern Australia in 1888. A long period of dry weather in the area, which ruined the family, gave start to Wilkins' interests in meteorology and oceanography. He believed that exploration of the polar areas and establishing weather stations would contribute to advanced warnings allowing people reasonable time to plan accordingly for the effects of long-term dry weather conditions.

Wilkins led an adventurous life as a war correspondent, photographer, air pilot and participant in several Arctic and Antarctic expeditions. He was, for example, second-in-command in an expedition to the northern coast of Alaska in 1913-16 during which he became aware that a submarine could go anywhere in the polar sea during the summer season. He soon came in contact with Simon Lake, who, in January 1898, wrote an article in the *New York Journal* that focused on the possibility of using a submarine in the work of polar investigations. The two developed a plan to go under the ice by submarine.

The Polar Expedition

The expedition was planned to start from Spitsbergen on June 15, 1931, pass under the North Pole and reach Alaska in a submerged condition. Both Wilkins and Lake were convinced the correct thing to do was to build a submarine especially for this expedition. Wilkins, however, did not have enough financial backing for such a project and, hence, he asked the U.S. Navy if the O-12 was available for the Arctic Expedition. An agreement was signed for leasing the O-12 for $1 per year with a commitment of returning the submarine to the Navy after the expedition.

An extensive reconstruction took place. This included a new superstructure with a dorsal sail for easier navigation below the ice, a new periscope, hull strengthening to resist the ice pressure, new batteries, complete overhaul of the engines, a new gyrocompass and echo sounder, a winch for hydrographic tests and one large and two small ice drills in order to get access to fresh air, as well as to pop up an antenna for sending and receiving radio signals. The torpedo room was also changed into an oceanographic laboratory. The project was financed through press contacts such as Hearst, as well as private sponsors like Lincoln Ellsworth.

Planned tests on the coast of Labrador were not carried out due to delays. Problems with the main machinery during the Atlantic crossing resulted in extra work at European shipyards and caused further delays.

Finally, on August 15, 1931, *Nautilus* reached Spitsbergen, which was supposed to be the starting point of the polar expedition. At this time, Wilkins decided to abandon his original plan of crossing the Arctic Sea under the ice, but instead prepared to get the most out of the situation in order to focus attention and interest for subsequent financing of an "ideal" submarine. When compact ice was reached at 81°25' North and the first test of submerging under the ice was carried out, both vertical rudders were destroyed and a further voyage below the ice became unthinkable.

Professor Sverdrup

Wilkins had asked Harald N. Sverdrup to participate on the polar expedition in the *Nautilus*, being in charge of the scientific projects. Sverdrup left his position at the Christian Michelsen Institute in Bergen and prepared himself with equipment and scientific material for test purposes. The *Nautilus* reached Bergen on August 1, 1931. On August 5, the course was set for the Arctic Sea by passing Tromsø and Spitsbergen. After an adventurous tour, described by Sverdrup in his book about the expedition, *Nautilus* returned to Bergen.

Turning over *Nautilus* to the U.S. Navy was out of the question because of the condition of the submarine. A crossing of the Atlantic during the winter was impossible. It was therefore decided to sink the *Nautilus* in deep water in the Bergen Bay Fjørd. On November 20, 1931, *Nautilus* reached its grave in 350 meters (1150 ft) of water. The incident was filmed and the recording shows the island of Askoy, which is located just outside of Bergen. This made it possible to locate the resting place of the *Nautilus*.

There are no plans at this time to recover this historic submarine.

BERGEN UNDERWATER SERVICES

BERGEN UNDERWATER SERVICES provides a wide range of underwater engineering consultancy services. It has been established for supporting other engineering companies and oil companies with the input from practical experience and field work. The aim is not to compete with the heavy engineering companies, but to fill the gap between theoretical sub sea engineering and the environment. Areas of expertise include:

- Design and development of subsea equipment
- Multifunctional dynamically positioned vessels
- Hydrographic Survey Instrumentation
- Manned submersibles including diver lockout operations
- Remotely Operated Vehicles

EDINBURGH GOLD SALVAGE COMPLETED

On September 12th, Wharton Williams completed the salvage of gold bullion from the wreck of HMS *Edinburgh*, which was torpedoed by German submarines in April 1942 while carrying the gold from Murmansk to Great Britain. It was to pay for Allied war supplies sent to the USSR.

In 1981, Wharton Williams broke all previous salvage records by recovering £43,000, 000 (about $64.5 million US) worth of gold bullion from a depth of 840 ft. in the Barents Sea. The salvage operation was curtailed due to the Arctic weather in the area, leaving just under half a ton of gold bullion remaining in the wreck.

Then, this summer divers emptied the bomb room in the *Edinburgh* where the gold was stored. The share of the gold belonging to the Soviet Union was transferred to their representatives at sea. 2W's salvage vessel, the *Deepwater 2*, owned by Brown & Root UK Ltd, arrived in Scotland on September 18th. In addition to the gold bullion, the divers located and recovered the ship's bell which 2W will present to the Royal Navy. And before leaving the wreck for the last time, an ex-RN diver placed a wreath on board the wreck in memory of the sixty officers and men who lost their lives on the *Edinburgh*.

El Nino may be on its way

Experts think it would be only a mild one this winter

By Kristine Moe
Staff Writer

Warm water in the central Pacific Ocean has continued to accumulate near the equator in the past few months, adding to the concerns of climatologists that another El Niño may be on its way this winter.

El Niño, a large-scale warming of the ocean accompanied by a disturbance in the atmosphere, can wreak havoc on worldwide weather and fishing conditions in severe instances, as in 1982-83.

However, all indications this year are that any El Niño would be mild and possibly would not be noticed by anyone except professional oceanographers and climatologists.

Scientists from the federal Climate Analysis Center in Maryland said in a statement released last week that "slow and irregular" changes in the central Pacific Ocean and atmosphere "are similar to those found during warm episodes" of an El Niño.

"Equatorial Pacific oceanic and atmospheric indices show that a mid-Pacific warming is now under way," said the statement, sent to scientists in the National Oceanic and Atmospheric Administration (NOAA).

The changes include heavier than normal rainfall in the eastern Pacific and a shift of the warmest water to the east.

"This marks the first time since the early stages of the 1982-83 (El Niño) that the warmest equatorial water has shifted eastward to that region." the statement said.

Additional evidence comes from a computer model that determined that the upper layer of warm water in the Pacific Ocean is deeper than normal near the equator. The model was developed by the NOAA's Geophysical Fluid Dynamics Laboratory at Princeton University.

That finding mirrors the conclusions reached last August by a research team from UCSD's Scripps Institution of Oceanography. Oceanographers Steve Pazan and Warren White had predicted months before that an El Niño would develop this year, and in August they said their study of July conditions provided the first direct evidence of the thickening of the warm-water layer.

"It's good to see this kind of confirmation of what we were saying all along," Pazan said.

The signs of an El Niño, though, are irregular, Pazan said. For example, the warm-water layer appeared to be thinning during August, he said. He doesn't yet know what happened in September, since he is waiting for that month's data to arrive from the volunteer commercial ships that take the measurements for Scripps.

The scientists at the Climate Analysis Center who wrote the statement could not be reached; they are meeting in Illinois this week to discuss the likelihood of another El Niño.

The 1982-83 El Niño was considered to be the worst in a century, and was blamed for causing between $2 billion and $8 billion in damages worldwide and for killing 1,300 to 1,500 people. The anchovy fishery off Peru was devastated because there was no upwelling of cool water from the ocean floor off the coast to provide food for the anchovies.

So far this year, said the climate center statement, cool-water upwelling off South America has been undisturbed. In addition, said Forrest Miller, scientist with the National Marine Fisheries Service in La Jolla, the fish harvests off the Central and South American coast this year have been better than normal, which is contrary to what happens during an El Niño.

ROV'87 ANNOUNCED

The Marine Technology Society, San Diego Section, has announced that ROV'87, the fifth annual conference and exhibition on remotely operated vehicles (ROV), will be held in San Diego, March 10-12. The event will be staged at San Diego's Town and Country Convention Center. More than 3,000 specialists in underwater technology are expected to attend.

ROV'87 will include as concurrent events, The Working Diver '87 and Special Sessions on Manned Submersibles. All will be produced under the rubric of INTERVENTION '87. In operations such as the search and recovery of the space shuttle *Challenger* and the survey of the *Titanic*, both manned and unmanned technologies were used to complete the job of subsea intervention. This often happens in the offshore oil & gas industry, as well.

A call for papers has been made on subjects regarding international development in the areas of ROVs, diving and combined operations. Abstracts of 200 words or less should be sent to the Technical Program Chairman no later than September 15, 1986. Authors of papers selected for presentation will be notified by mail no later than November 1. Final manuscripts must be received by ROV'87 by January 15, 1987. Please contact the Technical Program Chairman at P.O. Box 261149, San Diego, CA 92126. Tel: (619) 455-0102.

New laser, sonic devices help sound Arctic

(VOL. 7-NO. 42) AURORA NEWSPAPER (21 OCT. 1986) (C.F.B. GREENWOOD NOVA SCOTIA)

By John Michell

Two Canadian companies have developed methods of "sounding" (measuring water depths) from the air. The techniques differ but each is much more rapid and efficient than conventional surface methods.

An Ottawa company, Canadian Astronautics Limited (CAL), has shown that the depth of ice-covered water can be sonically measured from a helicopter passing overhead. This method could be especially useful for charting the course of future underwater pipelines in Canadian Arctic seas which, in some locations, may be covered with ice for 11 to 12 months of the year.

Optech Inc., a Toronto company, has developed a method based on "lidar" (light detection and ranging) which uses a laser beam to measure the depth of ocean water. The equipment, carried on an aircraft, includes a laser projector and a light-sensing device which detects the reflection of the laser beam from the bottom of the water or from submerged objects.

The laser method is expected to be used over any open body of water to find navigable routes for shipping, and may have other uses such as guiding and checking the progress of dredging operations.

Both methods should contribute vital information in support of the Canadian Government's determination to establish its sovereignty in the Canadian Arctic.

CAL's airborne sonic depth sounding is accomplished in a remarkably simple manner. A bullet is fired from a helicopter into the ice below, and a sensitive listening device attached to the aircraft registers not only the noise of the bullet's impact in the ice but also the echo from the sea bottom. A simple calculation gives the depth of the water.

Flying out of a research camp near Resolute, N.W.T., CAL scientists experimented with different rifle bullets and listening devices. A specially-shaped .300 calibre bullet, which made a particularly loud noise when it hit the ice, was developed. The rifle was carried on a special mount on the helicopter.

Before CAL developed the new system, the only way to do through-the-ice depth sounding was by repeatedly landing on the ice and setting up an echo-measuring device. The "mapping" rate was therefore extremely slow.

The new method permits depth sounding from a helicopter in continuous flight. As a result, vast areas of the ice-covered Arctic seas can be sounded rapidly and in relative comfort.

As an added bonus of the through-the-ice sounding method, the hardness and thickness of the ice can also be measured. This information is important for scientific and engineering applications, including ice-breaking.

The prototype system developed by CAL has been demonstrated to the Canadian Hydrographic Service. "We have obtained encouraging results, but there is much more work to be done," says CAL's Phillipe de Heering, who considers the new system to be the "first generation" of a series of further developments.

Optech's lidar system cannot be used over ice-covered water, but has been found so successful for use over open water that two new companies have been formed to take advantage of the market opportunities for both the hardware and the sounding device.

The lidar sounding system has been named LARSEN 500 for Captain Henry Larsen who commanded the first ship to traverse the Northwest passage from west to east, the R.C.M.P. vessel *St. Roch*.

In 1985, the LARSEN 500 was used to survey the southern route of the Northwest passage for the Canadian Hydrographic Service.

The sounder, when used over clear water, will detect underwater obstructions, or the bottom, to a depth of 30 metres, which is ample depth for surface vessels. The great advantage of the airborne system is that is 16 times as fast as the conventional shipborne acoustical sounding method (sonar).

"In one year, the LARSEN 500 can chart 90,200 square kilometres of water, while a conventional sonar system can cover only 5,800 square kilometres," says Optech's Bill Matvichuk.

The concept on which the LARSEN 500 system is based originated in the research of Professor Allan Carswell of the physics department of York University, Toronto, about 11 years ago.

The present device is fairly heavy and is carried on a specially equipped DC-3 aircraft. Now the system is being reduced in weight so that it may be carried in a helicopter.

Funding for the project was provided by the Canadian Hydrographic Service and several other government agencies.

(Canadian Science News)

Honeywell Restructures Tetra Tech Subsidiary

The Hydro Products and Advanced Technology Systems units of Tetra Tech, Inc., a Honeywell subsidiary, will now report directly to the dompany's Underseas Systems Division, under the title Tetra Tech Hydro Systems, effective last month. Tetra Tech, Inc., comprising the Water Management and Data Systems businesses, will continue to focus on the water resource management market.

"These changes reflect an effort to better focus our organizational capabilities on opportunities in naval support and water resource management," said Clinton Larson, group vice president of Honeywell's Marine Systems Group.

Tetra Tech Hydro Systems, headquartered in San Diego, California, develops, manufactures and markets harsh-environment viewing systems and undersea systems in support of the U.S. Navy's mine countermeasure and deep submergence programs.

SUBMERSIBLE NEWS AND VIEWS

from IRENE FAGER

DEEP SUBMERGENCE RESCUE VEHICLE MYSTIC (DSRV-1)
Naval Air Station, North Island
San Diego, California 92135

October 11,1986

Dear Irene,

Thought that you and your readers might appreciate an update on recent MYSTIC operations.

We just returned from NATO exercise SORBET ROYAL 86 which involved the simulated sinking of the Norwegian diesel submarine UTSIRA. Our unit mobilised and flew out from NAS North Island in San Diego with the DSRV on a C5 Galaxy and the remaining support equipment on a C-141. After landing at Sola Airport, Norway, the vehicle was transported to Dusavik harbor for onload aboard mother submarine USS BILLFISH (SSN-676). This was to be the first actual utilization of BILLFISH in this capacity.

A British submersible (LR-5), operating off the surface support vessel SALOMAR, was to attempt first contact with UTSIRA. These dives were aborted due to heavy seas. This demonstrated one of the advantages of the US NAVY's DSRS (Deep Submergence Rescue System) as we were completely unhindered by surface conditions during our submerged launch and recovery operations with BILLFISH.

The first dive on UTSIRA (dive 585) commenced on September 18 in poor conditions. A 2 knot cross current and low visibility made the search and mating evolutions difficult but in time a good seal was made on the Norwegian submarine's upper deck escape hatch. Once our mating skirt was pressure equalized and dewatered both subs opened their respective hatches for personnel transfer. Quick tours of both boats were conducted for each crew and then MYSTIC returned to BILLFISH to begin the routine of life support and battery replenishment.

Dive 586 progressed much faster in better conditions, allowing time for UTSIRA crewman to board MYSTIC and then be taken for a quick ride around their bottomed out submarine. MYSTIC again returned to BILLFISH with her original crewmembers.

The French diesel submarine AGOSTA was the "dissub" (distressed submarine) for the scenario of the final two dives of this series. Both dives were successful, again showing the worth of this US Navy system to our NATO allies.

After two days liberty in Stavanger, Norway, we once again loaded our vehicle and stores onto our two Air Force aircraft and returned to San Diego.

These four dives were documented on approximately 90 cachets which will begin being mailed out October 14.

Commencing on approximately October 20, MYSTIC will begin a 10-12 month overhaul, one that will significantly update our onboard computer, sonar, ship control, power distribution and inertial navigation capabilities.

NKK CERTIFIES SUB

Nippon Kaiji Kyokai has awarded a certificate of classification to the 39th submersible built by Kittredge Industries, Inc. of Warren, Maine. It is a two-man K-350L and was built under NK rules for the Japanese Shallow Sea Laboratory of Shimizu, Japan.

Captain George Kittredge, USN (Ret.), who is the president of Kittredge Industries, has had submarines of his design classed by ABS, Lloyd's and now NKK.

110 'saved' by US sub

Second time around

(Stavanger): The entire crew of a Norwegian submarine were 'saved' from their vessel off the island of Utsira near Stavanger last week. Nearly 500 people took part in 'Sorbet Royal 86', the first NATO rescue exercise of its kind.

The American rescue submarine *Mystic* was specially flown from California for the exercise. It arrived in a giant carrier aircraft at Sola airport September 15 and was loaded onto a ship waiting at Dusavik harbour.

The exercise began last Thursday when the Norwegian submarine *Utsira* 'sank' and couldn't resurface again. High seas and strong winds meant that the first rescue attempt by the British sub LR-5, and a mini-sub, had to be postponed. The specially-equipped support vessel *Challenger* was undergoing repairs in England and its replacement, the much smaller *Salmoor* couldn't lift LR-5 in the rough seas.

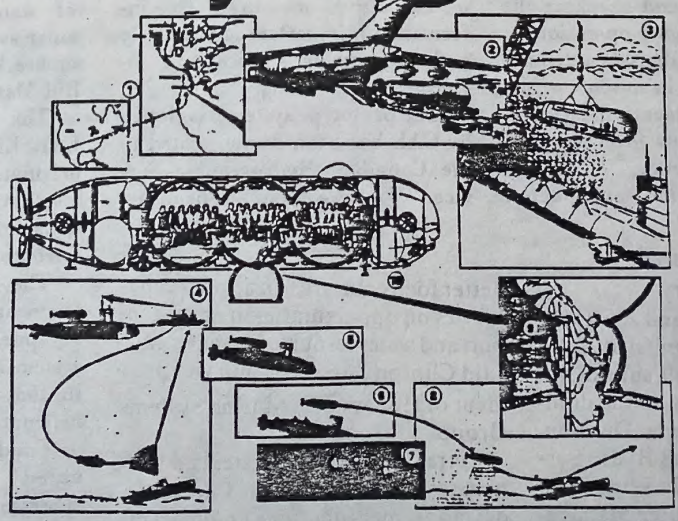
The problems surrounding the British rescue made it a more demanding test for the American vessel.

The 90-meter submarine *Billfish*, with *Mystic* mounted on its back, located the stricken *Utsira* which lay in 150 meters of water. *Billfish* stopped about 500 meters from the Norwegian submarine and let *Mystic* latch on to *Utsira* and rescue the crew.

There was great jubilation when *Mystic* returned successfully to reconnect with *Billfish* about two hours later.

Commanders aboard the *Billfish* were pleased with the results of the demonstration. They described the conditions as the most difficult they have performed in so far.

The British part of the exercise was later carried out in calmer waters north of Haugesund. There LR-5 and the remotely controlled mini-sub *Scorpio* made three successful dives connecting with the *Utsira* in 130 meters of water. LR-5, which can carry four people at a time, brought 12 men up from the Norwegian submarine to the mother ship.



Submarine rescue, step by step

(Illustration Aftenposten: Peter Viker)

1. Rescue sub Mystic is flown from California –
2. – to Sola airport, Stavanger, where it is taken by truck to –
3. – Dusavik harbour where a special crane is used to place it on the back of the American sub Billfish.
4. It travels to the area where the Norwegian sub Utsira *is lying on the seabed. Had weather permitted, LR-5 would first have located it and attached a sonar buoy to* Utsira.
5. Instead Billfish *goes down with* Mystic *on its back and locates* Utsira.
6 and 7. Mystic is released at 80 meters and goes down to Utsira *lying at 150 meters.*
8. Mystic puts its 'iron skirt' over Utsira's *hatch, water is pumped out and the two vessels are locked together.*
9. The crew of 'rescuer' Utsira clamber aboard the Mystic.

Exploring the mysterious world of deep sea sharks

by Don Grearson

What submarine pilot Tim Marzolf remembered most was the shark's big green eye against the black water 2,000 feet below the ocean surface.

"It was green, very green, almost phosphorescent," he said. "Beyond the shadows you could only see the eye. Its skin had a bit of brown but it was mostly grey.

"And when it opened its jaws, its teeth and gums were bright white. So bright I thought of a toothpaste commercial."

Mr. Marzolf was describing a scene very few people have seen: a deep water shark in its sunless world. It was a sight made possible by the Pisces VI, a submersible parked on the ocean bottom with Mr. Marzolf and *National Geographic* photographer Mr. Emory Kristof peering through its small portal windows.

The dive was one of the first of its kind; an exercise so simple in concept that, strangely, it had never been done before: parking a submersible in the deep to observe fish in their natural habitat.

The idea, if successful, could open up the dark, inaccessible deep to study and possibly lead to Bermuda's emergence as an international centre for deep water research.

The scientists and technicians diving this year off the Island call their work the Beebe Project, after naturalist William Beebe who penetrated the deep waters off Bermuda in a bathysphere in the 1930s.

Their work is the first long duration study of deep sea creatures since then and is focussed mainly on large creatures such as the six-gill shark that live in depths of 1,200 to 3,000 feet off the Bermuda seamount.

Using bait to draw the animals close and cameras to photograph them, the project hopes to track and study the movements, dispersion and feeding habits of fishes in the deep sea.

National Geographic's interest in deep water studies is strongly linked to that of Mr. Kristof, who is today's frontiersman of deep water photography. Using his understanding that it "is easier to photograph animals by attracting them rather than running them down," he came upon the novel idea to use a submersible as a blind.

Until now, mini-submarines have been used more to roam the ocean depths — a presence Mr. Kristof likened to an invasion of the deep "by the real sea monsters."

Submersible-bound scientists knew big creatures inhabited the great depths but their sightings were for the most part limited to clouds of stirred sand made by animals fleeing the large, noisy, bright, uneatable machines.

Mr. Kristof's submersible blind appears to be changing all that.

Last week, Pisces VI descended to 1,994 feet just beyond Chubb's Cut in a volcanic vent in the slope of the Bermuda mountain.

After a 30-minute descent, the submersible lit up a 150-foot area revealing a featureless, almost moonlike bottom of fine white sand. Just 18 minutes after the bait of tuna racks was set out in front of Pisces VI, a large shark appeared from under the sub's shadow.

Mr. Marzolf saw it first — its big, bald eye at one portal and its snout at another.

"Look at the size of that sucker," he said in a rising voice.

The fish, about 18-feet long and apparently well-fed, swam lazily out and around the bait, then to the periphery of the light and into the shadows. Moments later, it emerged from the right, moving slowly toward the cage-bound bait, opening its jaws over it, and, with a shake of its head, swimming off with the food in a swirl of sand.

"We need more bait," Mr. Kristof radioed to Mr. Teddy Tucker's boat above.

Two hours later the sub set down in the same vent with new bait. After 35 minutes, a 15-foot shark was spotted in the shadows beyond the submersible's light — a forbidding silhouette with a green eye.

The shark soon moved slowly into the light and to the bait, like a dog sniffing out food. Unperturbed by the brightness, it worked its jaws mouth around the bait and then swam toward the sub chomping into it.

Mr. Kristof considered the dive a great success. He had wanted to test whether the sharks were put off by the sub's lights and sonar pingers and its radio communications with Mr. Tucker's boat. He didn't think they were.

"The sharks took the bait in very smooth motions," he said. "It looked like they owned the property down there and weren't afraid of anything. The submersible was like a big rock. It just didn't register with them."

A second dive was held a few days later at the same trough. Mr. Kristof used different bait this time and experimented with the lights, leaving them off for extended periods and then turning them on the see what had gathered.

"There were swarms of little fish that we haven't been able to identify," he said. "They had double dorsal fins and clear, bulging eyes. They didn't seem to like the light and moved away from it. They changed directions rapidly and seemed to have a lot of randomness to their movements."

A small five-gill shark appeared for a time — its line sharp and well-defined like its surface cousins. Unlike the sharks of the previous dive, it moved in skittish, abrupt motions, and did not take the bait.

The observations gathered over the next few dives will play a key role in the development of the project next year and beyond — an agenda Mr. Kristof has big plans for.

He said he would like to set up a "supermarket" in the trough where this summer's dives have taken place — rigging the area with bait and cameras to attract not only sharks but the chain of animals that supports them.

He would also like to expand the study, working the area at 500-foot increments down to Pisces IV's 6,000-foot capacity.

On the basis of the dives made so far, Mr. Kristof is quietly hopeful that there may be enough of a case to keep the submersible in Bermuda on a year-round basis. The submersible blind, he believes, is an idea whose time has finally come.

"There is going to be a renaissance in science," he said. "Our work here could start a whole new line of research. People are going to start doing this because it provides such good first hand observation.

Cost-wise the Island is well-situated to become a centre for deep water research.

Its proximity to the deep makes it a low-cost location, removing the need for a mother ship.

"We can get a lot of bang for the buck here," Mr. Kristof said, adding that with Mr. Tucker and the Pisces VI daily diving costs are between $3,000 and $4,000 compared to $25,000 or more from a mother ship.

Mr. Kristoff's hopes are also boosted by the fact that ATT, the US corporate giant, is interested in Project Beebe because some of its new fibre-optic cable laid near the Canary Islands was chewed "like bubblegum" by deep water sharks.

"ATT would like to know why sharks bite the cable and whether it's possible to do something to keep it from being bitten and what level the cable could be laid to avoid such damage," Mr. Kristof said.

"To solve a problem like that could save the company hundreds of millions of dollars."

Don't worry — these creatures stay in the deep!

The first thing Project Beebe would like to make clear to Island residents and tourists is that the sharks it is studying are not the kind they are ever going to see off the beaches.

Deep water sharks are just that — inhabitants of the cold, sunless, nether regions of the oceans below 600 feet.

Two of their species are distinguished by six gills as opposed to five found in their shallow swimming cousins. Their eyes, adapted for the black environment, are large, round and green. Dr. Eugenie Clark, Project Beebe's shark expert, says specimens she has seen don't have eyelids although one seemed capable of forcing the surrounding skin down over its eye.

They are generally bulkier than surface sharks.

Key differences between the two shark types stem from the depths they inhabit. The liver of the deep water shark contains much richer oil for use as a bouyancy compensator. Shallow water sharks have a swim bladder instead. Also, deep water sharks don't have their cousin's big arm fins which prevent sinking.

Dr. Clark thinks a third species of deep water sharks may have been found by Mr. Teddy Tucker, who recently pulled up an oddly shaped tooth on a long line.

Dr. Clark's long term hopes for the Beebe Project are to draw some general conclusions about deep water sharks such as the way they feed, their reproductive orders, or whether they're sedentary, territorial, or nomadic.

Despite the large size of some of the sharks, Dr. Clark said they only need a really big meal once in a while.

"These sharks really have the capacity for a couple of hundred pounds of meat and that will hold them for a couple of months," she said. "In the interim, they pick up little things."

Shark expert in Cayman

The "shark lady", Dr. Eugenie Clark, was in Grand Cayman last week investigating the possibility of using research submersibles to study the feeding behaviour of her favourite creatures.

A marine biologist who is regarded as a world authority on sharks, Dr. Clark is the author of a 1952 best-seller, "Lady with a Spear", which recounts her introduction to the sea. "Lady and the Sharks" followed in 1968.

Dr. Clark was guest lecturer at the sixth annual Human Underwater Biology seminars held at Royal Palms Hotel last week. Teh seminars are organised by Drs. Bruce and Anita Bassett.

Dr. Clark is working on a grant from the National Geographic Society. According to a Cayman Islands News Bureau release, Dr. Clark said she chose this area of the Caribbean because of the clear water conditions which would enable her to study certain fish that inhabit the sandy ledges on walls like those found off Grand Cayman.

Dr. Clark and Dr. Bruce Bassett were photographed aboard the small submarine before making their deep dive with Research Submersible Ltd.

7-24-86

IRENE -

JUST WANTED TO LET YOU AND OHF KNOW THAT PISCES VI IS OPERATIONAL AGAIN AFTER BEING LAYED UP IN NEW YORK FOR SEVERAL YEARS.

WE HAVE BEEN DIVING HERE IN BERMUDA FOR THE PAST MONTH WORKING WITH NATIONAL GEOGRAPHIC SOCIETY SURVEYING SIX GILLED DEEPWATER SHARKS.

DIVES BS BROUGHT IN VIDEO & STILL PHOTOS OF 2 15' SHARKS FEEDING ON BAIT CARRIED BY PISCES.

WE WILL BE HERE FOR SEVERAL MORE DIVES TRYING OUT SOME OTHER EXPERIMENTS AS WELL.

UNFORTUNATELY, I WON'T BE ABLE TO SEND OUT MANY COVERS ON THIS PROJECT SINCE THEY ALL REQUIRE 40¢ BERMUDA POSTAGE. I DID HAVE SOME EXTRA STAMPS SO I THOUGHT I'D PASS ON A FEW.

BEST REGARDS - DON BARTHELMESS